QSH 215 A6

AMERICAN JOURNAL OF ALTERNATIVE AGRICULTURE

CAB INTERNATIONAL
00102558
12 APR 1994

1993

Volume 8, Number 3

Alternative Agriculture News

A monthly newsletter available from Henry A. Wallace Institute for Alternative Agriculture

This balanced and objective newsletter, with a sound track record of successful reporting, can help you keep track of national, state, and local action to support low-input, sustainable agricultural systems.

Alternative Agriculture News-

- Covers legislative developments at all levels of government.
- Summarizes reports and action by national, State, and local alternative agriculture organizations.
- Announces alternative agriculture conferences, meetings, and field days.
- Lists positions open.
- Announces important books and research reports.
- Highlights new alternative agriculture research and education initiatives.

Noted for its succinct yet comprehensive coverage, **Alternative Agriculture News** reports on action by all alternative agriculture groups. It covers:

- Universities and government agencies.
- Non-profit organizations.
- Industry.
- Environmental and farm groups.
- Consumer organizations.
- Private/public sector cooperative efforts.

By reading **Alternative Agriculture News**, you will be well informed about all of the major developments and trends in alternative agriculture.

Here's how to subscribe:

$16 Annual subscription (12 issues) to "Alternative Agriculture News" [$19 in Canada and Mexico; $26 all other countries].

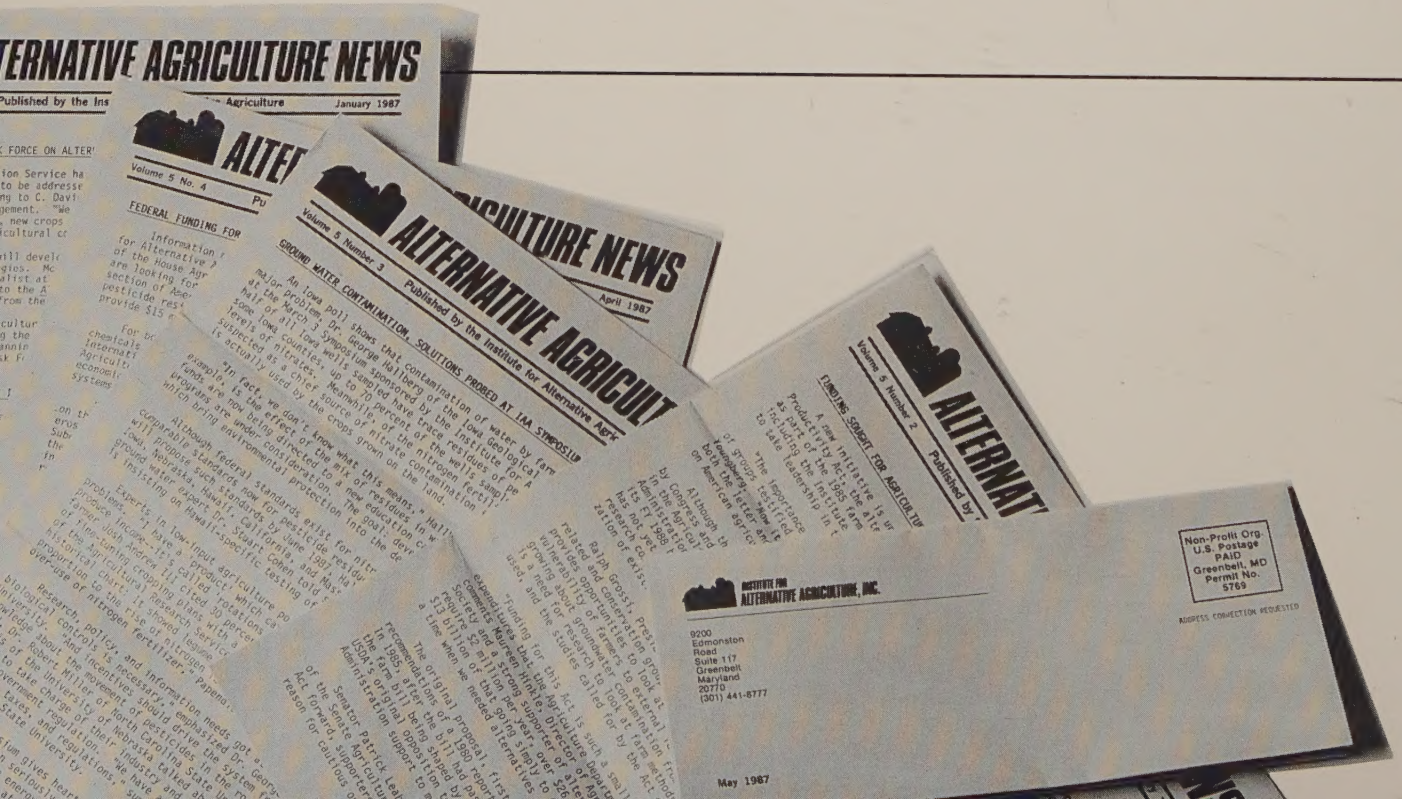
$24 Individual annual subscription (4 issues) to **American Journal of Alternative Agriculture** [$26 in Canada and Mexico; $28 all other countries]; *Library/Government/ Institutions Rates:* $44 in the U.S.; $46 in Canada and Mexico; $48 all other countries).

$35 Annual subscription package ($40 in Canada and Mexico; $49 all other countries) includes 12 issues of Newsletter and 4 issues of Journal.

Send check to: Henry A. Wallace Institute for Alternative Agriculture
9200 Edmonston Road, Suite 117
Greenbelt, Maryland 20770-1551

HENRY A. WALLACE INSTITUTE FOR ALTERNATIVE AGRICULTURE, INC.

9200 Edmonston Road, Suite 117
Greenbelt, Maryland 20770


ALTERNATIVE AGRICULTURE NEWS
Published by the Institute for Alternative Agriculture
Volume 5 Number 3
GROUND WATER CONTAMINATION SOLUTIONS PROBED AT IAA SYMPOSIUM
April 1987
Volume 5 No. 4
FEDERAL FUNDING FOR
January 1987
Volume 5 Number 2
FUNDING SOUGHT FOR AGRICULTU
ALTERNAT
INSTITUTE FOR ALTERNATIVE AGRICULTURE, INC.
9200 Edmonston Road Suite 117 Greenbelt Maryland 20770 (301) 441-8777
Non-Profit Org. U.S. Postage PAID Greenbelt, MD Permit No. 5769
ADDRESS CORRECTION REQUESTED
May 1987

AMERICAN JOURNAL OF ALTERNATIVE AGRICULTURE®

1993
Volume 8, Number 3

TABLE OF CONTENTS

Library Services Centre
12 APR 1994

Articles

98 **Agricultural policy debates: Examining the alternative and conventional perspectives** • Curtis E. Beus and Riley E. Dunlap

107 **Farmers' use of validity cues to evaluate reports of field-scale agricultural research** • Gerry Walter

120 **Barriers to low-input agriculture adoption: A case study of Richmond County, Virginia** • Penelope L. Diebel, Daniel B. Taylor, and Sandra S. Batie

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

REPLY MAIL
IT NO. 6232 GREENBELT, MD
E PAID BY ADDRESSEE

tute
ture
117
393

of Nebraska • Stephen R. Gliessman, University of California at Santa Cruz • Joan Gussow, Columbia University • Don F. Hadwiger, Iowa State University • Richard R. Harwood, Michigan State University • Glenn A. Helmers, University of Nebraska • Sharon B. Hornick, USDA-ARS • Larry D. King, North Carolina State University • Dietrich Knorr, University of Delaware • J. Patrick Madden, Madden Associates • Robert H. Miller, University of Rhode Island • Robert I. Papendick, USDA-ARS • James F. Parr, USDA-ARS/USAID • Richard L. Ridgway, USDA-ARS • Douglas L. Young, Washington State University • Raymond R. Weil, University of Maryland.

Wallace Institute Board of Directors

Kate L. Clancy, Syracuse, NY; President • Mrs. Jean Wallace Douglas, Washington, DC; Honorary President • Robert O. Blake, Washington, DC; Vice President • Michael Heller, Upper Marlboro, MD; Secretary • Richard J. Sauer, Chevy Chase, MD; Treasurer • Eugene W. Adams, Tuskegee, AL • Jim Bender, Weeping Water, NE • David F. Bezdicek, Pullman, WA • Jerald R. DeWitt, Ames, IA • John C. Gordon, New Haven, CT • William C. Liebhardt. Davis, CA • Ward Sinclair, Warfordsburg, PA • Anne K. Vidaver, Lincoln, NE.

Journal Staff

Editor — *Garth Youngberg*
Technical Editor — *William Lockeretz*
Associate Technical Editors —*Paul B. Marsh*
—*Neill Schaller*
—*Marion E. Simpson*
—*Katherine R. Smith*
Book Review Editors — *Thomas C. Edens*
— *James F. Parr*
Assistant to the Editor —*Sarah C. Byler*
Circulation—*Stephanie T. Filcheck*
Art Director— *Randy White*

Subscription Information

The *American Journal of Alternative Agriculture* (ISSN 0889-1893) is published quarterly (winter, spring, summer, fall) by the Henry A. Wallace Institute for Alternative Agriculture, Inc., 9200 Edmonston Road, Suite 117, Greenbelt, Maryland 20770-1551. The Wallace Institute is not responsible for statements and opinions expressed by authors. Annual Journal subscription rates: Library/Government/Institutions $44—US; $46—Canada and Mexico; $48—all other countries. Individuals $24—US; $26—Canada and Mexico; $28—all other countries. Students $12—US; $14—Canada and Mexico; $16—all other countries. Second Class postage paid at Greenbelt, MD. Postmaster: Send address changes to *American Journal of Alternative Agriculture*, 9200 Edmonston Road, Suite 117, Greenbelt, MD 20770-1551.

Wallace Institute Information

The Henry A. Wallace Institute for Alternative Agriculture is a nonprofit, tax-exempt research and education organization established in 1983 to encourage and facilitate the adoption of cost-effective, resource-conserving and environmentally-sound farming methods. It works closely with producer groups, public research and education institutions, and government agencies in promoting a sustainable agriculture system.

Its programs include providing a national information clearinghouse, serving as a voice for sustainable agriculture in Washington, and developing and implementing research and educational outreach programs. It holds an annual scientific symposium and publishes a monthly newsletter.

The Institute is governed by a grass roots Board of Directors, which includes several commercial-scale organic farmers, and maintains a small professional staff. It is supported by memberships and donations and grants from foundations, corporations, and individuals.

Cover Photo

The cover photo shows a pregnant crossbred sow ready to farrow in the hut on pasture at the Iowa State University Western Research Farm near Castana, Iowa. Linking livestock and crop production systems has been a traditional approach to achieving sustainability in the U.S. Corn Belt. Photo by Jack Coyier, ISU Photo Service, Ames, Iowa.

Alternative Agriculture News

A monthly newsletter available from Henry A. Wallace Institute for Alternative Agriculture

This balanced and objective newsletter, with a sound track record of successful reporting, can help you keep track of national, state, and local action to support low-input, sustainable agricultural systems.

Alternative Agriculture News-

- Covers legislative developments at all levels of government.
- Summarizes reports and action by national, State, and local alternative agriculture organizations.
- Announces alternative agriculture conferences, meetings, and field days.
- Lists positions open.
- Announces important books and research reports.
- Highlights new alternative agriculture research and education initiatives.

Noted for its succinct yet comprehensive coverage, **Alternative Agriculture News** reports on action by all alternative agriculture groups. It covers:

- Universities and government agencies.
- Non-profit organizations.
- Industry.
- Environmental and farm groups.
- Consumer organizations.
- Private/public sector cooperative efforts.

By reading **Alter News**, you will b all of the major trends in alternat

Here's how to subscribe:

$16 Annual subscription (12 issues) to "Alternative Agriculture News" [$19 in Canada and Mexico; $26 all other countries].

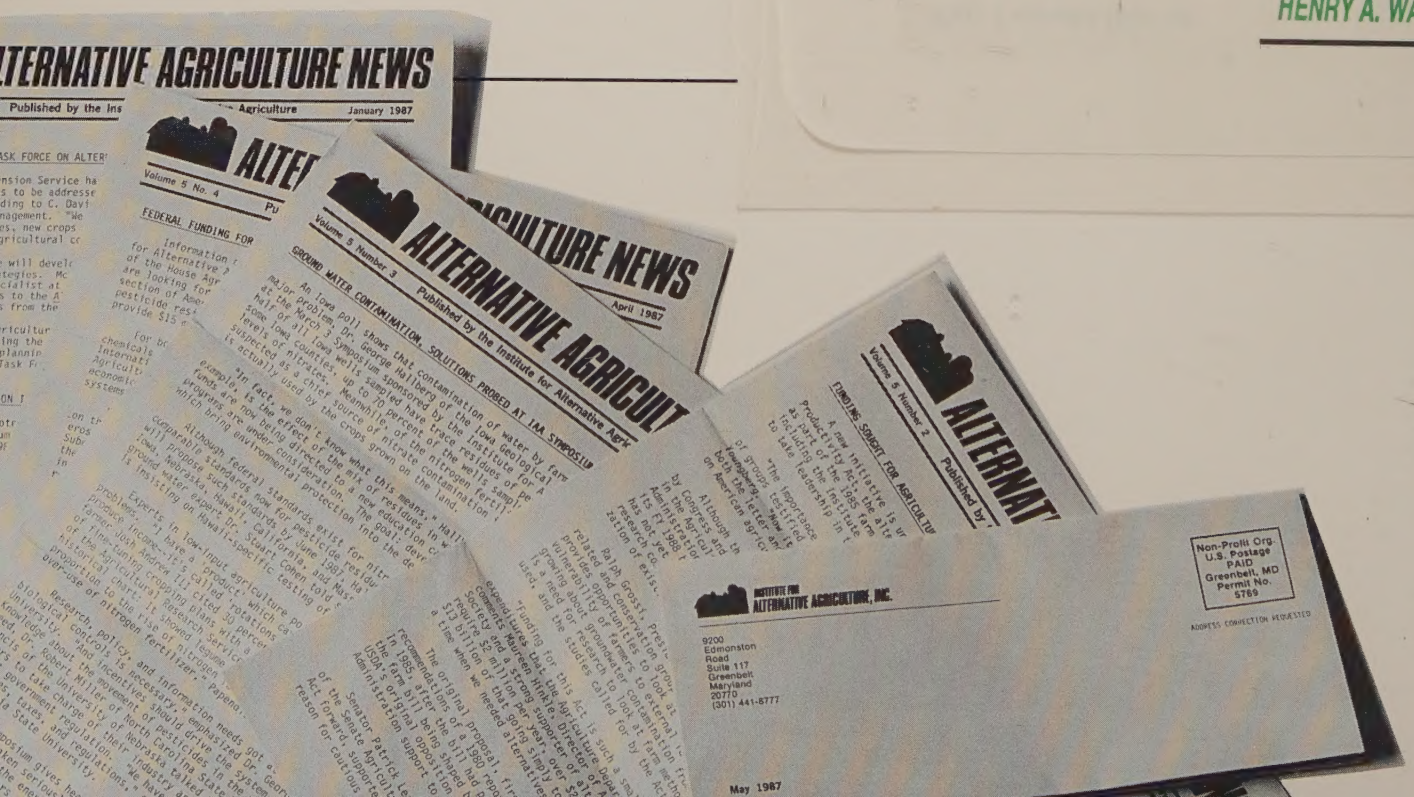
$24 Individual annual subscription (4 issues) to **American Journal of Alternative Agriculture** [$26 in Canada and Mexico; $28 all other countries]; *Library/Government/ Institutions Rates:* $44 in the U.S.; $46 in Canada and Mexico; $48 all other countries).

$35 Annual subscription package ($40 in Canada and Mexico; $49 all other countries) includes 12 issues of Newsletter and 4 issues of Journal.

The Henry A. Walla help dispel myths a tal characteristics a education, and policy development, we are wo ment agencies to develop and disseminate sound

If you would like to support the Institute's eff deductible contribution. *Thank you.*

HENRY A. WALLACE IN



AMERICAN JOURNAL OF ALTERNATIVE AGRICULTURE®

1993
Volume 8, Number 3

TABLE OF CONTENTS

Library Services Centre
12 APR 1994

Articles

98 **Agricultural policy debates: Examining the alternative and conventional perspectives** • Curtis E. Beus and Riley E. Dunlap

107 **Farmers' use of validity cues to evaluate reports of field-scale agricultural research** • Gerry Walter

120 **Barriers to low-input agriculture adoption: A case study of Richmond County, Virginia** • Penelope L. Diebel, Daniel B. Taylor, and Sandra S. Batie

128 **Environment-friendly swine feed formulation to reduce nitrogen and phosphorus excretion** • Mark S. Honeyman

133 ***Commentary*: Is sustainable agriculture an elixir for rural communities** • Paul Lasley, Eric Hoiberg, and Gordon Bultena

Departments

Institute News—118 • Resources—119 • Book Reviews—140 • Upcoming Events—143

Journal Editorial Board

Miguel A. Altieri, University of California at Berkeley • Molly D. Anderson, Tufts University • Lloyd A. Andres, USDA-ARS • David F. Bezdicek, Washington State University • Harold F. Breimyer, University of Missouri • Michael C. Brumm, University of Nebraska • Frederick H. Buttel, University of Wisconsin • Katherine L. Clancy, Syracuse University • Eliot Coleman, Harborside, Maine • Kenneth A. Cook, Center for Resource Economics, Washington, DC • R. James Cook, USDA-ARS • John W. Doran, USDA-ARS • Sara Ebenreck, St. Mary's College • Thomas C. Edens, Michigan State University • Frank P. Eggert, University of Maine • Lloyd F. Elliott, USDA-ARS • A. Dale Flowerday, Pioneer Hi-Bred International • Charles A. Francis, University of Nebraska • Stephen R. Gliessman, University of California at Santa Cruz • Joan Gussow, Columbia University • Don F. Hadwiger, Iowa State University • Richard R. Harwood, Michigan State University • Glenn A. Helmers, University of Nebraska • Sharon B. Hornick, USDA-ARS • Larry D. King, North Carolina State University • Dietrich Knorr, University of Delaware • J. Patrick Madden, Madden Associates • Robert H. Miller, University of Rhode Island • Robert I. Papendick, USDA-ARS • James F. Parr, USDA-ARS/USAID • Richard L. Ridgway, USDA-ARS • Douglas L. Young, Washington State University • Raymond R. Weil, University of Maryland.

Wallace Institute Board of Directors

Kate L. Clancy, Syracuse, NY; President • Mrs. Jean Wallace Douglas, Washington, DC; Honorary President • Robert O. Blake, Washington, DC; Vice President • Michael Heller, Upper Marlboro, MD; Secretary • Richard J. Sauer, Chevy Chase, MD; Treasurer • Eugene W. Adams, Tuskegee, AL • Jim Bender, Weeping Water, NE • David F. Bezdicek, Pullman, WA • Jerald R. DeWitt, Ames, IA • John C. Gordon, New Haven, CT • William C. Liebhardt. Davis, CA • Ward Sinclair, Warfordsburg, PA • Anne K. Vidaver, Lincoln, NE.

Journal Staff

Editor — *Garth Youngberg*
Technical Editor — *William Lockeretz*
Associate Technical Editors —*Paul B. Marsh*
—*Neill Schaller*
—*Marion E. Simpson*
—*Katherine R. Smith*
Book Review Editors — *Thomas C. Edens*
— *James F. Parr*
Assistant to the Editor —*Sarah C. Byler*
Circulation—*Stephanie T. Filcheck*
Art Director— *Randy White*

Subscription Information

The *American Journal of Alternative Agriculture* (ISSN 0889-1893) is published quarterly (winter, spring, summer, fall) by the Henry A. Wallace Institute for Alternative Agriculture, Inc., 9200 Edmonston Road, Suite 117, Greenbelt, Maryland 20770-1551. The Wallace Institute is not responsible for statements and opinions expressed by authors. Annual Journal subscription rates: Library/Government/Institutions $44—US; $46—Canada and Mexico; $48—all other countries. Individuals $24—US; $26—Canada and Mexico; $28—all other countries. Students $12—US; $14—Canada and Mexico; $16—all other countries. Second Class postage paid at Greenbelt, MD. Postmaster: Send address changes to *American Journal of Alternative Agriculture*, 9200 Edmonston Road, Suite 117, Greenbelt, MD 20770-1551.

Wallace Institute Information

The Henry A. Wallace Institute for Alternative Agriculture is a nonprofit, tax-exempt research and education organization established in 1983 to encourage and facilitate the adoption of cost-effective, resource-conserving and environmentally-sound farming methods. It works closely with producer groups, public research and education institutions, and government agencies in promoting a sustainable agriculture system.

Its programs include providing a national information clearinghouse, serving as a voice for sustainable agriculture in Washington, and developing and implementing research and educational outreach programs. It holds an annual scientific symposium and publishes a monthly newsletter.

The Institute is governed by a grass roots Board of Directors, which includes several commercial-scale organic farmers, and maintains a small professional staff. It is supported by memberships and donations and grants from foundations, corporations, and individuals.

Cover Photo

The cover photo shows a pregnant crossbred sow ready to farrow in the hut on pasture at the Iowa State University Western Research Farm near Castana, Iowa. Linking livestock and crop production systems has been a traditional approach to achieving sustainability in the U.S. Corn Belt. Photo by Jack Coyier, ISU Photo Service, Ames, Iowa.

Agricultural policy debates: Examining the alternative and conventional perspectives

Curtis E. Beus and Riley E. Dunlap

Abstract. *Control of agricultural policymaking by the "agricultural establishment" has been challenged by a wide range of interests concerned with the externalities of modern industrialized agriculture. An "externalities/alternatives" or "ex/al" coalition appears to be an emerging force in agricultural policy debates. We surveyed three alternative agriculture groups, three conventional agriculture groups, and a statewide sample of farmers to learn whether each category forms a distinct, unified interest group whose perspectives on agricultural policy diverge substantially from the others'. There is considerable similarity among the alternative agriculture groups and among the conventional agriculture groups, the differences between them being much greater than the differences within each category. The statewide farmer sample is generally intermediate between the two sets of interest groups, but is closer to the conventional perspective on most issues.*

Key words: alternative agriculture, conventional agriculture, agricultural chemicals, agricultural research, interest groups, lobbies, social movements

Introduction

For decades the "agricultural establishment" forged agricultural policy with little interference from outside forces. It wasn't until the mid '60s and early '70s that agricultural policy began to receive attention from "outsiders." Before that, agricultural policy was largely controlled by the major farm organizations, the agricultural committees of Congress, the USDA, and to some extent by land-grant colleges of agriculture. According to Paarlberg (1980), a major reason that non-agricultural groups have become increasingly involved in agricultural policy is that agriculture is rapidly losing its "uniqueness." That is, farmers and the agricultural industry are increasingly becoming homogenized into mainstream U.S. society and its industrial economy. According to Paarlberg, the traditional view of farming as a unique and virtuous way of life has dwindled as the farm population has declined, and as the remaining commercial farms were increasingly seen as the capital-intensive, competitive businesses they really are. He outlined a "new agenda" for agricultural policy made up largely of issues and problems defined by non-farm interests. Many of these new agenda issues, along with the groups that advocate them, appear to be gaining political credibility and power (Browne, 1988).

These new players in the agricultural policy arena have fragmented the policymaking process to the point that "the new universe of interest groups is beyond manageable proportions" (Browne, 1988, p. 252). As Browne acknowledges, however, this is not necessarily bad. In the past, the hegemony of the agricultural establishment often caused the interests of small farmers, environmentalists, rural communities, consumers, farm workers, and others to be ignored (Paarlberg, 1980; Hadwiger, 1982). Today, the consumer, environmental, farm labor, animal rights/welfare, and other lobbies are forcing the agricultural industry to deal—often for the first time—with many of the "externalities" that have long been largely ignored in U.S. agricultural policy. Issues such as water quality, the health effects of agricultural chemicals, rural poverty and the decline of rural communities, humane treatment of farm animals, farm workers' rights, agriculture's impact on wildlife and native ecosystems, and the nutritive value of increasingly processed foods are beginning to have an impact on agricultural policymaking.

Many analysts saw the farm bills of 1985 and 1990 as opportunities to break with entrenched agricultural policy that has changed only marginally since the New Deal. However, despite a widespread sense that U.S. agricultural policy needs an overhaul, both farm bills again proved to be evolutionary rather than revolutionary. Moreover, given the diversity of interests attempting to influence agricultural policy and the fact that no one group currently can speak as "the voice of agriculture," it is likely that food and farm policy will continue to change only marginally for the foreseeable future (Browne, 1988). Thus, while the agricultural policy agenda may not have been revamped as completely as many of the new interests would like, some change has occurred, and issues of the new agricultural agenda are likely to become increasingly important in future agricultural policy discussions.

Curtis E. Beus is Assistant Professor of Rural Sociology and Extension Economic Development Specialist, Texas A&M University, College Station, TX 77843-2124; Riley E. Dunlap is Professor of Sociology and Rural Sociology, Washington State University, Pullman, WA 99164-4006.

Alternative vs. Conventional Agriculture

Hadwiger (1982, pp. 150-168) refers to the many public interest groups that have recently become involved in agricultural policymaking as the "externalities/alternatives" or "ex/al" coalition. Browne (1988) also uses this term to refer to the so-called "lobby" of diverse interests made up of environmental organizations, consumer groups, farm labor organizations, animal rights/welfare activists, and many others. This loose coalition of interest groups is viewed with considerable contempt by many in the traditional agricultural establishment (Browne, 1988).

Despite many claims that these new interest groups know nothing about agriculture, the influence of the ex/al lobby appears to be growing (Paarlberg, 1980; Hadwiger, 1982; Browne, 1988). Although they are newcomers to agricultural policymaking, the ex/al lobby's power has increased rapidly and is often underestimated by traditional agricultural interests (Paarlberg, 1980). Moreover, because the issues addressed by the ex/al lobby often resonate with an increasingly urban population, it seems likely that its political influence will continue to increase. In contrast, even though traditional agricultural interest groups wield more economic power, they nevertheless represent a small and declining population base, and it, therefore, is likely that they will struggle to maintain their political clout.

It seems likely that a particular "hot spot" in agricultural policymaking will be the interactions between the ex/al lobby and the traditional power brokers. For example, Salisbury et al. (1987) found that major farm organizations, agricultural commodity groups, agricultural trade associations, and agricultural externality groups all tend to form alliances with groups similar to themselves. The groups from the first three categories also tend to look upon each other more as allies than as adversaries. However, the externality groups tend to look at most organizations in the other three categories as adversaries, and likewise are viewed by most mainstream agricultural groups as adversaries.

The current agricultural policy milieu, in which many new and traditional agricultural interests are vying for power, suggests that Browne (1988) is probably correct in his assessment that U.S. agricultural policy will experience only marginal changes in the near future. It is also likely, however, that any change that does occur will be influenced significantly by the policy objectives of the increasingly powerful and visible ex/al lobby.

What most of the seemingly disparate groups making up the ex/al lobby have in common is a deep, fundamental criticism of modern industrial agriculture and the agricultural policy that has accompanied and fostered it. We have previously argued (Beus and Dunlap, 1990; 1991) that the beliefs and values that underlie the political positions of many of these ex/al groups constitute an alternative paradigm for agriculture that is challenging the dominant conventional agricultural paradigm.

Purpose of the Study

To examine the policy positions of agricultural interest groups that adhere to these competing agricultural paradigms, we studied the members of six interest groups and a representative sample of farmers from Washington State. Three of the groups in the study represent the alternative or ex/al agricultural perspective, and three the conventional agricultural perspective. The primary purpose of this study is to investigate how the members of these different groups compare to one another—both within and between "camps"—and to statewide farmers in their views on various contemporary agricultural policy questions. (For a detailed discussion of how these six agricultural interest groups compare on a scale designed to measure adherence to the conventional and alternative agriculture paradigms, see Beus and Dunlap [1991]).

We are not aware of any empirical studies of how the policy positions of ex/al groups compare among themselves or with those of conventional agriculture interest groups. It is not known, for example, whether different ex/al groups share similar policy positions and thus constitute a reasonably unified lobby. Similarly, it is unclear whether groups representing the conventional agriculture perspective represent a reasonably unified lobby for promoting their interests. Moreover, while groups representing these competing agricultural perspectives are assumed to differ dramatically in their policy orientations, little is known concerning which issues most separate them and on which issues, if any, they hold similar positions.

Methods

Sample selection

Although the ex/al lobby is broader than environmental groups alone, environmental concerns are perhaps most important to its political agenda. Therefore, the three groups we selected to represent the alternative agriculture position are primarily concerned with environmental aspects of agriculture, even though they espouse other ex/al concerns (Beus and Dunlap, 1991). The alternative agriculture samples studied were the Washington State members of the Northwest Coalition for Alternatives to Pesticides (NCAP), a regionally active anti-pesticide lobby; Washington State affiliates of Permaculture, a loosely knit international organization that advocates agricultural practices and policies radically different from modern, conventional agriculture; and farmers certified as organic by the Washington State Department of Agriculture.

The groups chosen to represent conventional agriculture were Washington members of the Pacific Northwest Aerial Applicators' Alliance (AAA), a regionally active lobby on behalf of pesticide use, especially aerial application of pesticides; state and county officers of the Washington State Farm Bureau; and registered agricultural chemical dealers from Washington State.

For comparative purposes we obtained a sample of all Washington State farmers from the Washington Agricultural Statistics Service, stratified by gross farm sales. We randomly selected 200 farmers from each of the six strata: $1,000 to $9,999; $10,000 to $39,999; $40,000 to $99,999; $100,000 to $249,999; $250,000 to $499,999; and over $500,000. For all analyses, the responses of the statewide farmer sample have been weighted to rep-

resent the farm population of Washington based on the 1987 Census of Agriculture.

Survey implementation

The conventional and alternative groups were surveyed by mail in November and December of 1989, and the statewide farmer sample in March and April 1990. Questionnaire construction and survey implementation for both surveys followed Dillman's (1978) total design method (TDM). Information on sample sizes and response rates is presented in Table 1. Response rates were good, given that funding limitations prevented us from employing a third follow-up as is recommended with the TDM.

Five questions on general agricultural policy issues and twelve on more specific agricultural policy issues were included in a twelve-page questionnaire for the agricultural interest groups and in an eight-page questionnaire for the statewide farmer sample. Both surveys contained other questions, but this paper will focus only on responses to the policy items.

Table 1. Sample sizes and response rates for each group.[1]

	PC	NCAP	OF	State Farmers	FB	ACD	AAA
Sample size	139	138	144	1200	204	68	67
Number ineligible[2]	6	2	0	15	1	0	0
Number returned	104	110	103	680	146	39	46
Response rate (%)	78.2	80.9	71.5	57.4	71.9	57.4	68.7

[1] PC = Washington State Permaculture Members
NCAP = Washington State members of the Northwest Coalition for Alternatives to Pesticides
OF = Washington State Certified Organic Farmers
State Farmers = Stratified random sample of Washington State farmers
FB = State and county officers of Washington State Farm Bureau
ACD = Washington State licensed agricultural chemical dealers
AAA = Washington State members of the Pacific Northwest Aerial Applicators' Alliance

[2] The number ineligible are those whose questionnaires were not deliverable by the Postal Service, deceased individuals, and in the case of the statewide farmer sample those who indicated that they are retired and no longer farm.

Results

The seriousness of agricultural problems

Compared with the conventional groups and Washington farmers, the alternative agriculture groups tend to view the problems currently facing U.S. agriculture as more serious, although Table 2 shows that a majority of all seven groups believe the problems are very serious. Of the conventional groups, AAA members view agricultural problems as most serious, while the Permaculture activists are most likely among alternative agriculturalists to view them as very serious.

Opinions varied on which type of problems—environmental, economic, or social—are most serious. Between 30% and 41% of the respondents in the conventional agriculture interest groups said environmental problems are most serious, with only slightly more (between 46% and 52%) indicating that economic problems are most serious. By comparison, only 23% of the statewide farmer sample view environmental problems as most serious, with 65% responding that economic problems are most serious.

It seems surprising that the conventional agriculture groups view environmental problems as more serious than do Washington State farmers. A possible reason is that the conventional agriculture interest groups are less affected by the tough economic times in farming than are the statewide farmers, although most of the Farm Bureau respondents are farmers themselves, as are some respondents in the other two groups. Also, because of the generality of the question, many conventional agriculture group members (many of whom are commercial applicators of agricultural chemicals) may have said that environmental problems are most serious because they perceive their conflicts with environmental interest groups as an "environmental problem" in agriculture. Further research with more specific items would be needed to determine if this is the case.

As expected, the alternative agriculture interest groups overwhelmingly singled out environmental problems as most serious. However, this is less true for the certified organic farmers, who view environmental problems as only moderately more serious than economic problems (52% vs. 34%). As with the comparison between statewide farmers and conventional groups, this may be because the organic farmers make their living by farming, whereas many of the respondents in the other alternative agriculture groups do not. Somewhat surprisingly, only between 5% and 15% of each sample view social problems as most serious.

Agricultural research priorities

These findings are especially curious considering the responses to item 3 in Table 2. When asked to choose among three broad goals for publicly funded agricultural research, the alternative groups, conventional groups, and farmers each selected a different goal as most important. We designed this item to correspond roughly with item 2, which asks respondents which of the three types of agricultural problems is most severe. Item 3 offered the following choices as the *major* goal for publicly funded agricultural research: 1) making agriculture more productive and efficient (economic problems); 2) making agriculture more environmentally sound (environmental problems); and 3) preserving family farms and revitalizing rural areas, which we thought roughly corresponded with "social problems." Judging from the responses, however, it appears that the third response category, with its phrase "preserving family

Table 2. Attitudes toward general agricultural issues by sample (%).[1]

Abbreviated Survey Items[2]	PC	NCAP	OF	State Farmers	FB	ACD	AAA
HOW SERIOUS ARE PROBLEMS IN AGRICULTURE?							
Very serious	87	77	71	59	55	59	71
Somewhat serious	13	23	28	35	42	39	22
Not serious	0	0	1	3	2	0	7
Unsure/undecided	0	0	0	3	1	3	0
WHICH PROBLEMS ARE MOST SERIOUS?							
Environmental	80	79	52	23	41	30	39
Economic	7	10	34	65	52	46	46
Social	10	5	13	9	5	15	7
Unsure/undecided	3	7	2	3	2	9	9
MAJOR GOAL OF PUBLICLY FUNDED AGRICULTURAL RESEARCH							
Increase productivity and efficiency	1	4	6	19	39	32	48
Make agriculture more environmentally sound	76	85	46	20	19	22	23
Preserve family farms/revitalize rural areas	16	9	40	55	31	30	27
Other	7	3	7	6	11	16	2
YOUR VIEW OF THE CURRENT AGRICULTURAL CHEMICAL CONTROVERSY							
Food system is safe	1	5	17	61	86	76	91
Food system is unsafe	95	88	77	17	6	5	4
Unsure/undecided	4	7	6	22	9	18	4
DO YOU FAVOR OR OPPOSE LISA							
Favor	96	98	88	53	70	46	37
Oppose	1	1	4	18	12	27	39
Unsure/undecided	3	1	8	29	19	27	24

[1] See Table 1, footnote 1 for full names of each group.
[2] Complete wordings of items are available from the authors.

farms," is perhaps viewed more in economic than social terms.

The statewide farmer sample overwhelmingly selected this area of research as most important. This also is the group that views economic problems as the most serious facing agriculture, yet only 19% of them believe making agriculture more efficient and productive should be the most important goal of publicly funded agricultural research. Farmers may believe that increasing productivity and efficiency only exacerbates economic problems in agriculture because it leads to chronic surpluses and lower commodity prices. Further study is needed to learn if farmers believe that making agriculture more efficient and productive is incompatible with preserving family farms and revitalizing rural areas, and if so, how they propose to revitalize rural areas, and to what extent research should emphasize maximizing agricultural efficiency and productivity. Although the conventional agriculture interest groups are less likely than the statewide farmer sample to say that economic problems are the most serious problems in agriculture,

they are far more likely to say that the major goal of publicly funded agricultural research should be to increase agricultural efficiency and productivity (from 32% to 48%).

About one-fifth of both the conventional agriculturalists and farmers said that making agriculture more environmentally sound should be the major goal of agricultural research, compared with over three-fourths of the Permaculture activists and NCAP members. Organic farmers, while considering environmental soundness to be the most important agricultural research goal (46%), nevertheless were nearly as likely to say that preserving family farms and revitalizing rural areas should be the major goal of research (40%). Only between 1% and 6% of the members of the alternative agriculture interest groups believe that making agriculture more efficient and productive should be the major goal of research.

Agricultural chemicals

Item 4 in Table 2 shows that the safety of the U.S. food system, a major issue in agricultural policy debates, sharply divides the opposing camps in our study. Ninety-five percent of Permaculture activists, 88% of NCAP members, and 77% of organic farmers said that the U.S. food system is unsafe because of agricultural chemicals, while only 4% of AAA members, 6% of Farm Bureau officers, and 5% of agricultural chemical dealers expressed this view. A sizable minority of the statewide farmer sample believe that the U.S. food system is unsafe (17%), with 22% unsure or undecided.

In 1988 the USDA began a research program known as "Low Input Sustainable Agriculture," or LISA (now called the "Sustainable Agriculture Research and Education" program, or SARE). A major goal of LISA is to develop agricultural systems that use significantly lower amounts of agricultural chemicals, both to reduce environmental damage and to cut production expenses. The last item in Table 2 shows, not surprisingly, that all three alternative agriculture groups overwhelmingly favor the LISA program. The Farm Bureau is the only conventional agriculture interest group that clearly favors the LISA program, with the AAA and agricultural chemical dealers more evenly split on the issue. It is understandable that significant portions of these groups oppose the LISA program, since members of both groups make their living by selling and applying agricultural chemicals. Perhaps the surprise is that the LISA effort is *favored* by such large proportions of the conventional agriculture groups—37% to 70%, with an additional 19% to 27% unsure or undecided about it. (In contrast, only between 1% and 8% of the alternative agriculture groups are unsure or undecided about LISA.) Of the statewide sample of farmers, more than half (53%) favor the LISA program, while only 18% oppose it and 29% are unsure or undecided.

Specific policy items

Table 3 presents all groups' responses to a set of more specific agricultural policy items. Respondents were asked to evaluate each item on a five-point scale: strongly agree, mildly agree, unsure/undecided, mildly disagree, and strongly disagree. To simplify interpretation, we have combined the two "agree" categories and the two "disagree" categories. Although this masks some subtleties in the response patterns, it does not substantially alter the overall patterns of group responses.

Conservation and farmland preservation. All groups agree that farmers should *not* receive government subsidies unless they have adopted an adequate soil conservation plan (item A). This idea, sometimes called "cross-compliance," is most strongly supported by the alternative agriculture groups, as expected. However, large majorities of the statewide farmer sample and all of the conventional agriculture groups other than the AAA also agree with the idea. A similar pattern is seen in item B, with all groups agreeing that stricter regulations are needed to prevent farmland from being converted to nonfarm uses; only the Farm Bureau officers voiced significant disagreement with this item.

Government subsidies. Farmers and many others involved in agriculture often say that many problems would go away "if only the government would get out of agriculture." Perhaps the most pervasive way that government involves itself in agriculture is through commodity price supports and other subsidies. For all samples, far more respondents agree than disagree that government subsidies to agriculture should be phased out (item C), with the ratio varying from nearly 2 to 1 (NCAP) to almost 4 to 1 (organic farmers). The conventional agriculture groups and statewide farmers agree to a greater degree than two of the alternative agriculture groups. The conventional agriculture samples are also more likely to have formed an opinion on this issue (from 2% to 15% unsure/undecided) than are the alternative agriculture groups (from 29% to 34% unsure/undecided). Perhaps the alternative agriculturalists, while disliking the current programs, nevertheless believe that some form of subsidies are necessary to support their goals. Several items below also touch on this subject.

Agricultural exports. Responses to item D show how differently alternative agriculturalists view agriculture compared to conventional agriculturalists and Washington State farmers. Farmers and members of the conventional agriculture interest groups overwhelmingly agree (from 92% to 98%) that increasing exports of agricultural products should be a major goal of U.S. agricultural policy, whereas support for increasing agricultural exports is much lower among the alternative agriculture interest groups (from 18% to 58%). However, as with the issue of agricultural subsidies, a substantial proportion (from 17% to 32%) of alternative agriculture group members are unsure or undecided about increasing agricultural exports.

Number of farms. The U.S. farm population has been declining rapidly since the 1940s. Many farmers have been forced to expand to keep pace with rising production costs and stagnant commodity prices, while others have been forced out of agriculture or have chosen to farm part-time while earning most family income from off-farm sources. Substantial majorities of the alternative agriculture groups and statewide farmer sample agree that U.S. farm policy should aim to increase the number of farms, especially small to medium-sized family farms (item E). The conventional agriculture groups also tend to agree with this goal, but to a lesser de-

Table 3. Percent agreeing and disagreeing with various agricultural policy statements.[1]

Abbreviated survey items[2]		PC	NCAP	OF	State Farmers	FB	ACD	AAA
A. No subsidies without soil conservation plan	Agree	96	98	88	82	81	74	58
	Disagree	2	0	2	11	14	8	26
	Unsure/undecided	2	2	10	7	5	18	16
B. Stricter regulations on conversion of farmland to other uses	Agree	90	93	80	71	59	72	78
	Disagree	4	4	15	20	34	23	9
	Unsure/undecided	6	3	5	9	7	5	13
C. Subsidies to agriculture should be phased out	Agree	47	42	64	60	63	72	63
	Disagree	22	24	17	25	29	26	22
	Unsure/undecided	31	34	19	15	8	2	15
D. Increasing agricultural exports should be a major policy goal	Agree	18	34	58	92	96	97	98
	Disagree	52	34	25	4	3	0	2
	Unsure/undecided	30	32	17	4	1	3	0
E. Increase number of farmers, especially small to medium-sized family farmers	Agree	84	94	82	75	53	68	59
	Disagree	8	6	10	14	38	18	22
	Unsure/undecided	8	0	8	11	9	14	19
F. Regulations on pesticides and other agricultural chemicals should be strengthened	Agree	97	98	82	48	38	37	24
	Disagree	1	2	12	41	55	61	73
	Unsure/undecided	2	0	6	11	7	2	3
G. Small farms should get proportionally greater subsidies than large farms	Agree	62	70	50	51	32	33	20
	Disagree	15	10	25	29	54	44	53
	Unsure/undecided	23	20	25	20	14	23	27
H. Strictly regulate genetic engineering even if it slows development of biotechnologies	Agree	85	78	55	34	26	33	33
	Disagree	7	9	15	30	43	38	35
	Unsure/undecided	8	13	30	34	31	29	32
I. No subsidies without adequate agrichemical compliance program	Agree	84	87	76	64	57	46	44
	Disagree	3	7	11	22	33	18	48
	Unsure/undecided	13	6	13	14	10	36	8
J. U.S. farm policy should be aimed at large farms that produce the majority of the food supply	Agree	1	6	1	10	21	8	13
	Disagree	90	90	95	82	70	82	72
	Unsure/undecided	9	4	4	8	9	10	15
K. Government should regulate nitrogen fertilizer use in areas with contaminated groundwater	Agree	98	97	81	70	53	54	62
	Disagree	2	1	12	20	34	38	29
	Unsure/undecided	0	2	7	10	13	8	9
L. Government should develop programs to protect farmers converting to reduced chemical farming methods	Agree	86	90	53	50	39	28	7
	Disagree	8	7	37	33	43	67	89
	Unsure/undecided	6	3	10	17	18	5	4

[1] Original response categories were: "Strongly agree," "Mildly agree," "Undecided or unsure," Mildly disagree," and "Strongly disagree." The two "Agree" and "Disagree" categories have been combined in this table.

[2] Complete wordings of items are available from authors.

gree than alternative agriculturalists and farmers statewide.

Regulation of chemicals. As we saw earlier, the alternative agriculturalists differed dramatically from the statewide farmer sample and the conventional agriculturalists regarding agricultural chemicals and the safety of the U.S. food system. Item F shows that the alternative agriculturalists almost unanimously agree that regulations on agricultural chemicals should be strengthened. The conventional agriculture groups, while not as unified, nonetheless disagree with this position by about a 2 to 1 margin. Opinions on this issue are clearly defined, with very few from either camp indicating that they are unsure or undecided on this issue. The statewide farmer sample, on the other hand, is slightly more likely to be uncertain about increasing regulations (11% unsure/undecided), and is almost evenly split between those who agree and disagree over stronger regulations (48% vs. 41%).

Subsidies and farm size. Whether government subsidies should be used to support farmers' income or to manage agricultural commodity supplies has long been debated. Subsidies are currently based on the amount produced, so that larger farms receive greater subsidies. Although a $50,000 payment limitation per farm has been in place for years, many large-scale farmers have found ways of getting around it. All samples exhibit considerable uncertainty (14% to 27%) on whether subsidies should support smaller, low-income farms to a proportionally greater degree than larger, high-income farms (item G). The alternative agriculturalists are more likely than the other samples to agree that smaller farms should receive proportionally greater subsidies. However, the organic farmers are less likely to agree than the other alternative agriculture groups (50% agree vs. 25% disagree). The statewide farmer sample is nearly twice as likely to agree (51%) as disagree (29%) that smaller farms should get proportionally larger subsidies. It is only the conventional agriculture groups who tend to disagree with this policy position, and then only to a modest extent.

Related to this issue is the question of whether agricultural policy should be geared primarily toward enhancing the productivity and efficiency of the large-scale farms that produce the majority of our food supply (item J). All samples tend to disagree with this statement, even the conventional agriculturalists. Although the conventional agriculture groups do not favor preferential subsidies for smaller farms, and believe that agricultural research should focus on increasing agricultural efficiency and productivity, they do not favor agricultural policies that would explicitly give preferential treatment to large farms.

Biotechnology. Not surprisingly, the alternative agriculture samples strongly agree that biotechnology should be strictly regulated (item H), although a large minority of organic farmers (30%) are undecided. In contrast, the conventional agriculture interest groups are slightly more inclined to disagree than agree that biotechnology should be strictly regulated, with significant portions of all three samples undecided. Farmers are intermediate between the two sets of interest groups and are almost evenly split on this issue (34% agreeing and 30% disagreeing), with 36% responding that they are unsure or undecided.

Agrichemical compliance. The results for item I are perhaps among the most surprising. While most alternative agriculturalists (from 76% to 87%) agree that farmers should not receive subsidies unless they adopt an adequate agrichemical compliance plan, we did not expect such large proportions of farmers and conventional agriculturalists to agree with this policy position. The AAA is the only exception, splitting almost evenly (48% disagreeing and 44% agreeing). Almost half (46%) of the agricultural chemical dealers agree that farmers should have an adequate agrichemical compliance program before they receive any subsidies, with only 18% disagreeing and 36% undecided. Similarly, the Farm Bureau officers also favor agrichemical compliance programs by almost a 2 to 1 margin. The statewide farmer sample expressed even stronger agreement (64% agreeing and 20% disagreeing). This is particularly puzzling because as we noted earlier, the conventional agriculturalists agree that regulations on agricultural chemicals should not be strengthened. Since agrichemical compliance plans are not currently required for farmers to be eligible for subsidies, requiring farmers to adopt them would appear to be a new regulation—something the conventional agriculturalists say they oppose.

Nitrogen Fertilizer Regulation. Responses to item K also are somewhat surprising. Majorities of all groups, including the statewide farmer sample and conventional agriculturalists, agree that N fertilizer use should be regulated in areas where water supplies have been contaminated. Again, this would appear to be a new regulation, yet even the groups who say they oppose further regulation of agricultural chemicals tend to favor this policy. Perhaps many respondents do not consider N fertilizer to be an "agricultural chemical," and thus see no inconsistency. It could also be that farmers see this issue as a "real" problem that farmers are aware of and feel should be confronted, since nitrate contamination of aquifers is becoming a serious problem in some parts of Washington State and the nation. To examine more closely the apparent inconsistencies between respondents' views on regulation of chemicals (item F) and their positions on agrichemical compliance (item I) and regulation of N fertilizers (item K), we cross-tabulated the responses for the conventional agriculture groups and statewide farmer sample. (The alternative agriculture groups are not included in this analysis because their responses to these items did not indicate any inconsistencies.) For this analysis, all three conventional agriculture groups were combined.

For both the farmers and conventional agriculture groups, those who favor increased regulations on chemicals also overwhelmingly favor agrichemical compliance plans and regulation of N fertilizer use in problem areas (80% and 86% respectively for the farmers, and 75% and 68% for the conventional agriculture groups). Moreover, the farmers who *oppose* increased regulations on chemicals nevertheless *support* regulation of N fertilizer use in problem areas by about a 3 to 2 margin, and are almost evenly split on the issue of agrichemical compliance plans (45% in favor and 43% opposed). Members of the conventional agriculture groups who oppose increased regulations on chemicals are almost evenly split on both

issues (47% in favor and 42% opposed to regulation of N fertilizers, and 40% in favor and 45% opposed to agrichemical compliance plans).

These results show that although majorities of farmers and conventional agriculture interest group members say they oppose increased regulation of agrichemicals generally, they nevertheless modestly support two specific policy options that would introduce more regulation of agricultural chemicals. Additional research is needed to examine this apparent contradiction. Are individuals who say they oppose increased regulations of agricultural chemicals more likely to favor new regulations if the regulations address specific, recognized problems? Are these surprising findings unique to Washington State farmers and agricultural interest groups?

Conversion to reduced-chemical methods. Earlier we saw that all groups, especially the conventional groups and the statewide farmer sample, tend to agree that agricultural subsidies should be phased out. The conventional agriculture groups likewise oppose programs that would subsidize farmers going through the risky transition to reduced-chemical farming systems (item L). AAA members oppose such a policy especially vehemently (89% disagree). In contrast, Washington State Farm Bureau officers are split almost evenly on the issue (43% disagree and 39% agree).

As expected, all alternative agriculture groups favor this type of policy, with Permaculture and NCAP members agreeing at 86% and 90%, respectively. Organic farmers are considerably less likely to favor assistance for farmers converting to reduced-chemical farming systems (53% agree and 37% disagree). Perhaps this is because they have already converted on their own without governmental assistance and believe that assistance would give other farmers an unfair advantage. They probably also recognize that if more farmers convert to reduced-input systems, especially organic systems, this would increase competition in organic markets and drive down prices for organic commodities.

Summary

All groups in this study—alternative agriculturalists, conventional agriculturalists, and farmers—agree that agriculture faces serious problems. They generally differ, however, on which problems are viewed as most serious and on the policies needed to correct them. Conventional agriculturalists tend to favor phasing out subsidies, but if subsidies are available they favor conservation and to some extent agrichemical compliance to receive them. They also favor increasing agricultural productivity, minimizing regulations on agricultural chemicals, and increasing agricultural exports. Conventional agriculture groups overwhelmingly believe the U.S. food system is safe and regard the current controversy over agricultural chemicals as unwarranted. All three conventional agriculture interest groups are similar in their response patterns. However, the Farm Bureau officers differ from the other groups on a few items. They are much more likely to favor the LISA program, more likely to favor conservation and agrichemical compliance requirements for subsidies, somewhat more likely to favor governmental assistance for farmers converting to reduced-chemical methods, and less likely to favor strict restrictions on converting farmland to nonfarm uses.

Alternative agriculturalists also tend to favor phasing out agricultural subsidies, but to a lesser degree and with more uncertainty than do conventional agriculturalists. The alternative agriculture groups strongly support soil conservation and agrichemical compliance as requirements for receiving subsidies. They see the U.S. food system as unsafe, and strongly support research to make agriculture more environmentally sound. They also support stronger regulations on agricultural chemicals, strict regulations on biotechnology, and restrictions on converting farmland to nonfarm uses. Although the three alternative agriculture groups responded similarly on most items, the organic farmers differ substantially from the other two groups on agricultural exports, regulation of biotechnology, and assistance to farmers converting to reduced-chemical systems.

The responses of the statewide farmer sample generally are intermediate between the positions of the two sets of interest groups, but typically are closer to the conventional position. On a few issues, however, such as increasing the number of farmers and preferentially subsidizing smaller farms, the farmers are closer to the alternative position.

These results show that there are consistent and significant differences in the policy orientations of the alternative and conventional "camps," with farmers generally falling in between. The one policy issue on which the groups differ very little, however, is the phasing out of agricultural subsidies, with all groups moderately favoring their elimination. Knutson et al. (1986) contend that eliminating subsidies, especially if done rapidly, might actually accelerate the trend toward larger but fewer farms. Perhaps this is why significant portions of the alternative agriculture samples are undecided on this issue. Nevertheless, at least in principle, many participants in agricultural policy debates agree that subsidies should be eliminated.

As long as subsidies exist, however, alternative and conventional agriculturalists differ significantly in how they should be distributed. Alternative agriculturalists, and even to some extent Washington state farmers, believe that smaller farms should get proportionally larger subsidies. Alternative agriculturalists are also more likely to insist on soil conservation and agricultural chemical compliance as a condition for receiving subsidies.

None of the groups in this study show significant support for direct subsidies, the largest and among the most controversial areas of agricultural policy, yet all groups differ considerably on certain aspects of the subsidization issue. Moreover, there is a great deal of uncertainty about the necessity of subsidies, especially among the alternative agriculture groups. It is likely that individuals from all groups look upon subsidies as a necessary evil. Further research is needed to determine whether this ambivalence will remain, or whether it is merely a temporary phase as individuals and groups sort the pros and cons of agricultural subsidies.

We have shown that besides differing in their general orientations toward agriculture, that is, in their agricultural paradigms (Beus and Dunlap, 1990; 1991), these groups also differ substantially in their agricultural policy preferences. On many issues, alternative and conventional agriculture interest groups hold strongly opposing positions. There also are differences among the groups within each category. Nonetheless, the differences within the alternative and conventional camps are minor compared to the differences between them.

Conclusions

The agricultural establishment quietly but effectively controlled agricultural policy for decades, but as Paarlberg (1980) has pointed out, a new agenda has been taking shape for U.S. agriculture over the past twenty years. Browne (1988), however, cautions against assuming that this new agenda will lead to radical and quick changes in actual policy. Although they have definitely grown in power and influence, Browne sees the ex/al groups—which have been largely responsible for shifting the focus of the agricultural policy agenda—as too fragmented and weak to take control of agricultural policy the way that the agricultural establishment did in the past.

Strange (1989) believes that more farmers are beginning to support aspects of this new agenda, such as revitalizing rural communities, preserving small to medium-sized family farms, conserving resources, and protecting the natural environment. Our study suggests that farmers are close to the ex/al positions regarding family farms and rural revitalization. However, farmers tend to be intermediate between the alternative and conventional positions on many environmental issues, and are perhaps closer to the conventional perspective on some key environmental issues such as the safety of the U.S. food system and regulation of agricultural chemicals.

Will the interests of the various stakeholders in agricultural policy-making remain fragmented and often contradictory as Browne predicts, or will the ex/al lobby he describes become better organized, and even be joined by significant numbers of farmers as suggested by Strange? Conversely, can agribusiness and other conventional agriculture interests come up with a strategy to regain effective control of agricultural policy? It appears highly unlikely that anything resembling the old agricultural establishment can regain control of agricultural policy. Moreover, if the agricultural policy arena remains as fragmented as it now is, policy changes will continue to be slow and marginal, as Browne predicts. If, however, the alternative agriculture position continues to grow and gain supporters from formerly conventional farmers and others, an effective coalition could be built and policy change could be more rapid and fundamental (Strange, 1989; Youngberg and Buttel, 1984).

Agricultural policy appears to be caught in a stalemate as these competing interests focus on their often very specific and narrow concerns. Although many analysts agree that agricultural policy is in need of a major overhaul, this will be impossible without considerable compromising and coalition-building, so that a comprehensive and coherent set of agricultural policies can be adopted. Our results suggest that any attempts to achieve the needed compromises must be based on a thorough appreciation and understanding of the fundamental differences that divide many of the participants in current agricultural policy debates.

References

1. Beus, C.E., and R.E. Dunlap. 1990. Conventional vs. alternative agriculture: The paradigmatic roots of the debate. Rural Sociology 55(4):590-616.
2. Beus, C.E., and R.E. Dunlap. 1991. Assessing alternative vs. conventional agricultural paradigms: A proposed scale. Rural Sociology 56(3):432-60.
3. Browne, W.P. 1988. Private Interests, Public Policy, and American Agriculture. Univ. Press of Kansas, Lawrence.
4. Dillman, D.A. 1978. Mail and Telephone Surveys: The Total Design Method. John Wiley and Sons, Inc., New York, N.Y.
5. Hadwiger, D.F. 1982. The Politics of Agricultural Research. Univ. of Nebraska Press, Lincoln.
6. Knutson, R.D., J.W. Richardson, and E.G. Smith. 1986. Impact of farm policies on agriculture, farm structure, and rural communities. Southern Rural Sociology 4:31-42.
7. Paarlberg, D. 1980. Farm and Food Policy: Issues of the 1980s. Univ. of Nebraska Press, Lincoln.
8. Salisbury, R.H., J.P. Heinz, E.O. Laumann, and R.L. Nelson. 1987. Who works with whom? Interest group alliances and opposition. Amer. Political Sci. Review 81(4):1217-1234.
9. Strange, M. 1989. Family Farming: A New Economic Vision. Univ. of Nebraska Press, Lincoln.
10. Youngberg, G., and F.H. Buttel. 1984. Agricultural policy and alternative farming systems: Politics and prospects. In S.S. Batie and J.P. Marshall (eds). Restructuring Policy for Agriculture: Some Alternatives. Papers from a symposium. Information Series 84-2. Virginia Polytechnic Institute and State Univ., Blacksburg. pp. 45-66.

Organic Product Sales Increase 23 Percent to $1.5 Billion in 1992

Aided by increased availability, new markets, and new organic product introductions, sales of organic products increased 23% to $1.5 billion in 1992, and accounted for 28% of overall natural products industry sales, according to the 1992 Organic Market Overview by *Natural Food Merchandiser* and *Organic Times*. Sales of organic produce increased 30% to $242.3 million in 1992; organic deli sales increased more than 80% to $114.7 million. Organic product sales directly from farmers to consumers were estimated at $315 million in 1992, a 16% annual increase, because of more farmers' markets, "pick your own" farms, and Community Supported Agriculture groups. New organic markets and products include organic cotton clothing, gourmet organic specialty foods and eateries, and organic beverages such as wine.

Farmers' use of validity cues to evaluate reports of field-scale agricultural research

Gerry Walter

Abstract. *On-farm and farmer-directed research is claimed to lack validity when produced by methods that limit the generalizability of its results. However, farmers may consider such findings sufficiently valid for use in agricultural production even though agricultural scientists may not consider them scientifically valid. A general social-psychological theory of knowledge and information processing called lay epistemology suggests that farmers may assess the validity of any research report by its plausibility in relation to their knowledge and experience. Other communication research suggests that readers will look for cues to help them decide whether the research and findings are valid and useful.*

To identify validity cues used by farmers in evaluating production research reports, we asked 56 Illinois cash-grain farmers to mark phrases and other items that influenced their confidence in a popularized research report and to explain the reasons for each mark. The kinds of validity cues that farmers used or sought had little relationship to their personal or enterprise characteristics. The researcher's name, location and affiliation were critical cues, but information on the methods and results were no more important than data about costs, risks, growing conditions, and longer term outcomes. Plausibility plays a key role when farmers decide whether production research is valid. It would be useful to farmers if research reports included more information about the system being studied, such as its costs and risks, along with data on the research methods used.

Key words: on-farm research, agricultural communication, validity assessment, research design

Introduction

Interest in farmer-directed research and education has renewed the old tension between common sense and refined knowledge. Some farmers and agricultural scientists regard alternatives to rigorously controlled experimentation, including on-farm development and testing of alternative farming practices, as a logical and necessary component of a sustainable system of agricultural production (Jackson, 1987; Hecht, 1988; Kloppenburg, 1991). However, others question the generalizability of results from farmer-run or quasi-experimental studies of farming practices (Molnar et al., 1992). An important question is whether and how to communicate research findings that may have great practical relevance for farmers but limited scientific generalizability.

Fundamental to this question is the socially determined nature of validity. No statement or set of research findings is inherently valid; rather, its validity hinges on whether it is persuasive and plausible by the standards of the group that is evaluating it (Kruglanski, 1989). For applied research, valid findings must be generated in a way that is widely accepted as valid, be plausible given what we already know, and make sense for "real" situations (Restivo and Loughlin, 1987).

Kruglanski (1989) argues persuasively that the validity of scientific findings also derives from communication through "official" channels to which only those employing valid modes of inquiry presumably have access. All information systems employ standards to establish the validity of the information their members create, disseminate and use. However, every standard leaves considerable room for negotiation over what ought to be considered valid (Restivo and Loughlin, 1987).

In the agricultural information system, validity standards are largely prescribed by academic researchers (Kloppenburg, 1991; Walter, 1991). Farmer-generated information—including findings of farmer-directed on-farm research and less formal, experiential knowledge—is not regularly disseminated by conventional information channels such as the farm press, the Cooperative Extension Service, or private consultants. In part this is because it often is derived using different or less rigorous methods than those employed by academic scientists, and because it originates from unfamiliar or unconventional sources. However, Rzewnicki et al. (1988) suggest that quasi-experimental designs in farmers' fields can yield valid and useful results. Properly conducted and replicated, they can yield more data than carefully controlled studies about how a practice or product performs under a broader range of environmental conditions. Although they do not necessarily meet all the validity standards of academic science, such findings nonetheless must meet the standards of the farmers expected to put them into practice. We need to understand these

Gerry Walter is Assistant Professor, Office of Agricultural Communications and Education, University of Illinois at Urbana-Champaign, Urbana, IL 60801.

standards so that we can design studies that farmers and other practitioners will accept, and deliver effectively the recommendations derived from them.

This study explored the elements that farmers use to assess the validity and potential usefulness of an applied agricultural research communication. Its premise is that informational communication must carry cues that enable its audience to evaluate its validity and its usefulness for subsequent decision making.

The Validity Assessment Process

According to a general model of cognitive judgment and inference called lay-epistemology (Kruglanski, 1989), all knowledge is propositional and, therefore, subject to challenge by alternative propositions (hypotheses) derived from observation of the surrounding environment, including communications. Confronted with an alternative hypothesis, such as a potentially better production practice recommended in an agricultural research report, a person tries to confirm or disconfirm it using several sources of evidence: the report's content, such as the research methods used; its context, such as how it was obtained and the reliability of the person who recommended it; and its appearance (perhaps even the slickness of the paper). Inference and knowledge-building, therefore, involve a mental screening process by which information likely to be helpful is selected from an environment filled with data (Dervin, 1983). Facts or data, such as research findings, that are deemed valid can be incorporated into working knowledge for use in making decisions and solving problems. The validity of a fact, assertion or other observation, therefore, requires confidence not only that it was derived using methods that make it generalizable beyond its original context, but also that it will be useful in the concrete situation where the potential user is considering using it. A person seeking evidence to help confirm or disconfirm a lay-epistemic hypothesis thus will require cues that permit evaluation on both methodological grounds and practical relevance.

Sources of validity cues

Studies of the lay-epistemology model (Kruglanski, 1980; Kruglanski and Freund, 1983; Mayseless and Kruglanski, 1987; Kruglanski and Mayseless, 1988) have found that the cues a person uses to validate an assertion will vary with the topic, the individual's existing knowledge (including both attitudes and factual knowledge), and the way the validity assessment problem is framed. Kruglanski (1989) suggests that choice of cues also can vary with different social, situational, cultural and economic conditions. We do not know, however, which specific cues are important in a given context and what each contributes to the assessment of validity.

Forms of evidence

Because statistical evidence is a common basis for scientific inference, scientists routinely use statistical cues to evaluate the validity of research results. But with scientific methods regarded as authoritative in an ever-widening sphere of human activities, as Postman (1992) suggests, non-scientists also might be expected to give greater weight to statistical cues than to non-statistical forms of evidence, such as testimonials, anecdotes and narratives. Evaluating general audiences' responses to different types of evidence, McQuarrie (1984), Kline (1969) and Harte (1972) have found that statistical evidence adds to an argument's persuasiveness. Petty and his associates (Cacioppo et al., 1983; Petty and Cacioppo, 1984; Petty et al., 1980) have found statistics especially influential when accompanying descriptions of research methods. They also have found that use of statistics makes the information source more credible; that is, people will have more trust in the communicators and, presumably, the communications that come from them (Petty et al., 1981). However, others have found that statistical evidence is less effective, irrelevant, or detrimental in persuading people that an argument has merit (Kahneman and Tversky, 1973; Ajzen, 1977; Borgida and Nisbett, 1977).

Sources of evidence

Research results produced and disseminated by "official" sources and channels carry presumptive validity within their relevant "validity communities" (Restivo and Loughlin, 1987; Kruglanski, 1989), so the identity of a source or channel thus might be a validity cue. Traits that have been found to affect whether a communicator is considered credible include the audience's perceptions of the communicator's trustworthiness, accuracy, fairness and expertise (Hovland and Weiss, 1951; Berlo et al., 1970; Gaziano and McGrath, 1986). However, Delia (1976) argues that credibility results not from a communicator's general traits but from the perception that a communicator has expertise appropriate to the situation. I have suggested (Walter, 1991) that in agriculture, where a few institutional sources speak with authority, title and institutional affiliation are a source of credibility for people offering production advice and therefore may provide cues for assessing the validity of the advice they offer.

Social context

Members of an information system develop common standards for demonstrating and inferring the validity of what they communicate. Therefore, they are likely to regard the same or similar attributes of communication content, form and context as cues for assessing validity; they know what evidence to look for when evaluating an assertion, and what evidence to include when making one. Nonetheless, they do not all necessarily use the same validity criteria and cues. Scientists, for example, demand research results that are generalizable across some population of interest. Farmers, in contrast, must assess the validity of information not only in the scientific sense but also in relation to production and perhaps other household activities (Suppe, 1987; Kloppenburg, 1991). Francis et al. (1989) have found that realism, visibility, and producer input often contribute more than experimental design to whether a farmer regards research results as useful; this apparently involves standards and cues related to usefulness along with (or perhaps

in place of) statistical significance and generalizability.

Study Objectives

The present study, conducted during the summer of 1991, sought to identify the cues farmers use to assess the validity of research-based communications about agricultural production methods, and whether differences in the cues they use are related to easily identifiable personal or enterprise characteristics. I examined a particular kind of communication, agricultural research reports intended for a farming audience. While any communication (or its context) contains cues for judging validity, research reports are of particular interest because they have a clearly defined concept of valid knowledge accepted by many other agricultural information sources (Walter, 1991). They also are of special interest because some people are skeptical about whether they are valid and useful in actual farming situations (Suppe, 1987; Gillespie and Buttel, 1989).

Materials and Methods

Study participants

Fifty-six farmers of 58 randomly selected from county Farm Bureau mailing lists were interviewed between June 12 and July 29, 1991. All but three were Farm Bureau members, and all lived within 45 miles of the University of Illinois. Given their proximity to the university and the Illinois Farm Bureau's historically strong ties to the college, the participants may have more contact with and more positive views of the college's agricultural research and extension programs than non-members or farmers in other areas. However, Farm Bureau members make up more than 70% of the three counties' commercial farmers, and as a whole the participants' demographic and farm characteristics are typical of the area's commercial cash grain farmers.

The participants, all males, ranged in age from 25 to 82, and had from 2 to 50 years of farming experience (median of 16 years). Half had baccalaureate degrees, most from the University of Illinois. They raised from 212 to 3,800 acres of crops, with an average of 989 acres. Half of them rented more than 90% of their cropland, generally on a crop-share basis. Half grew at least some of their crops on contract for nearby seed or food processing firms. Thirteen also had livestock operations.

Sample research reports

Each participant read a four-page document presenting general information on the use of cover crops for weed control and the results of two field tests of cover crops for weed control in corn and soybeans. The experimental document was laid out in the style of a Cooperative Extension Service (CES) bulletin and included an Illinois CES logo on the last page.

The bulletin's general information was adapted from a publication produced by University of Wisconsin-Madison agronomists (UWEX, 1989). It explained the rationale for using cover crops for cultural and biological weed control, described in general terms some methods for each kind of control, and offered some cautions about the use of cover crops. Although cover-crop weed control is not common in east-central Illinois, some farmers in the area do use it.

The bulletin's field tests and results were adapted from two single-year (1990) trials sponsored by the Illinois Department of Energy and Natural Resources (1991). The first was a test of annual ryegrass and buckwheat to replace chemical herbicides for weed control in corn. Cosponsored by a soil conservation district in northwestern Illinois, it used one-acre fields (but no control fields) and produced corn yields consistent with local averages and the field's history (127 and 129 bu/acre). The second test, co-sponsored by the Southeastern Illinois Sustainable Agriculture Association, a farmer group, also ran for one year. It compared fall-seeded rye for weed control in 18 acres of soybeans with chemical weed control in a 64-acre control field.

Two forms of the bulletin were prepared. One stated that the tests of cover crops were performed at the University of Illinois' research farms in east-central Illinois; the other gave the tests' actual on-farm sites in other parts of the state. Both reported identical information about the tests, including field size, tillage and planting operations, plant populations, chemical treatments, timing of operations and yields of agronomic crops; no data were offered on soil types, weed pressure, or previous crops. The information reported in the bulletin was the same as that from the actual on-farm trials, except that yields were increased to be more consistent with east-central Illinois yields, so that participants would be less likely to consider the study's findings invalid or not useful because yields were unusually low. Corn yields were increased by 30 bu/acre (to 157 bu/acre and 159 bu/acre); in the soybean test, where actual yields were attenuated by extremely wet conditions during the test year, yields were increased by 16 bu/acre (to 52.1 bu/acre for the treatment and 50.2 bu/acre for the control). Three readers — extension specialists in crop production and communications and an area farmer — reviewed first and final drafts of the document and judged the final draft's content as appropriate for an extension bulletin on cover-crop weed control.

Identifying cues and assessing validity

Participants were randomly assigned to read one or the other form of the bulletin. All participants were instructed to mark, while reading the bulletin, all words, phrases, numbers, and other content that they believed added to or subtracted from their confidence in the validity (further defined, if requested, as correctness or accuracy) of assertions made in the bulletin. They also were asked to explain their marks briefly as they made them. After reading, they again were asked the reasons for each mark, how each marked cue affected their confidence in the assertions in the bulletin, and what further information about the research in the bulletin would increase their confidence in its validity. Participants also evaluated the methodological validity and practical relevance of the information in the bulletin by answering two questions: "How valid is the research reported in the pamphlet?" (clarified where necessary as "How confident are you that the tests were done properly?"); and "How likely are the practices described in the pamphlet to be useful on your farm?" The rating scale ranged from 0 (not at all valid/useful) to 20 (extremely valid/useful). Respondents also said whether they

were familiar with cover crops for weed control, either because they used them, or because they previously had read or heard about them.

Classification of cues

For analysis, the sample bulletin's content was divided into 217 potential cues: words, phrases, numbers, headings, and graphic images deemed to represent separable "chunks" of meaning that a reader might use to assess the validity of the bulletin's content. The general introductory material was classified into 107 potential cues; the reports of the two sample research projects comprised 110 cues. All content was classified, and no content was classified as more than one cue.

The potential cues were reclassified into 34 more general categories—17 each for the general material and the research reports; the subsequent discussion involves only the research-report categories (Figure 1). For each of these categories, a participant received a score of 1 if he had marked

Each of the 110 cues (words, phrases, figures) in the research report section of the sample bulletin was classified into one of 17 categories. Following are the criteria for assigning cues, and examples of cues; the number of cues assigned to each category appears in parentheses.

Test sponsor (2):
identifies sponsor of test or person who conducted test—e.g., Jo Daviess County Soil and Water Conservation District, University of Illinois, the university

Test location (6):
identifies site of test—e.g., near Stockton, in northeast Illinois, research farms, in Urbana

Test year (2):
identifies year test was done—1990

Study objectives (7):
identifies purpose of test—e.g., evaluated replacing corn herbicides with annual ryegrass and buckwheat cover crops

Study design (12):
identifies presence or absence of controls, replications or other aspects of study design—e.g., two field plots

Field size (3):
identifies size of fields in tests—e.g., 1 acre, 64 acre

Tillage operations (12):
identifies pre- and post-planting tillage operations—e.g., plowed, disked, cultivated

Planting methods (6):
identifies row spacing, plant populations or planting processes of agronomic or cover crops—e.g., 38-inch rows, 25,000/acre plant population, aerial seeded

Chemical application (6):
identifies chemical application methods—e.g., burndown, band

Chemical names (8):
identifies specific chemicals used—e.g., Roundup, Turbo, 2,4-D

Chemical rates (10):
identifies application rates for herbicides and other chemical inputs—e.g., 6 oz/acre, 1 gal/acre

Other inputs (8):
identifies other inputs used—e.g., 28% nitrogen, adjuvant, molasses

Timing of operations (13):
identifies actual or approximate date of tillage, planting, weed control, harvest or other operations, intervals between operations, or relative order of operations—e.g., on May 8, in spring, two-week intervals, pre-plant

Equipment used (4):
identifies brand or generic type of equipment used in tillage, planting, weed control or other crop production operation—e.g., broadcast seeder, rolling-tine cultivator

Yields (4):
identifies yields of agronomic crops—e.g., 157 bu/acre

Advice, study A (6) and Advice, study B (3):
identifies observations or recommendations attributed to corn test or soybean test—e.g., both cover crops established and made good growth, the rye cover proved to be an especially effective weed control method

Figure 1. Cue categories and classification criteria.

any of the category's component cues, and 0 otherwise. A factor analysis reduced the 17 research-report categories to five groups—cultural practices, study design/results, inputs, sponsorship, and summary advice—that explain 66.1% of the total item variance (Table 1). To preserve the multiple-factor identity of cue categories that load strongly on two factors, such as "field size," factor scores (rather than additive scales) were calculated to indicate each participant's relative use of each of the factor-derived groups.

Participants' requests for further information were classified into 13 categories (Figure 2); a participant received a score of 1 for each category for which he requested more information, and 0 otherwise. Factor analysis reduced these to six groups—conditions/outcomes, potential problems, technologies, study design specifications, costs, and profits—that explain 67.2% of total item variance (Table 2). Each participant was assigned a factor score for each of these groups.

Findings

Effects of on-farm vs. research farm site

Participants reading the two forms of the sample bulletin showed no statistically significant differences (at the $p < .10$ level) in their assessments of the validity and usefulness of the bulletins or in the number and kinds of cues they reported using. Both groups therefore were combined for subsequent analysis.

Assessments of validity and practical relevance

The 56 participants' average rating of the methodological validity of the research was above the midpoint of the 21-point "not valid/extremely valid" scale (Table 3). Most rated the research's practicality lower, but the ratings of validity and practical relevance show a modest positive correlation. The overall validity scores show no statistically significant association with years of farming experience or levels of formal education. However, participants educated at a land-grant university (LGU) and those who were familiar with the use of cover crops tended to express less confidence in the research's methodological validity. On the other hand, those with more cropland tended to give the research

Table 1. Rotated factor matrix of research-report validity cue categories marked.

	I	II	III	IV	V
Equipment used	***.835***	.236	.090	.125	.013
Tillage operations	***.770***	-.173	.222	.360	-.101
Timing	***.759***	-.082	.061	.073	.175
Planting methods	***.733***	.308	.174	.002	-.112
Field size	***.606***	.564	-.097	-.044	.226
Study objectives	***.538***	.254	-.083	.334	.111
Study design	.191	***.800***	.064	.152	.022
Chemical applications	.345	***.549***	.481	.077	.102
Yields	-.135	***.548***	.257	.363	-.023
Chemical names	.091	-.044	***.792***	-.141	.154
Other inputs	-.000	.084	***.780***	.141	-.096
Chemical rates	.228	.406	***.622***	.021	.112
Test sponsor	.129	.135	-.015	***.824***	-.015
Test location	.181	-.044	.095	***.698***	.095
Test year	.105	.317	-.080	***.655***	.174
Advice (study A)	-.032	-.060	.198	.105	***.821***
Advice (study B)	.127	.166	-.065	.086	***.803***

Additional cues desired are data about the tests that participants said they would need or like to know to make a more confident judgment of either test's validity. Expressions of additional cues desired were abstracted from interview transcripts and classified into 13 categories according to their fit with the following definitions.

Researcher name:
information to enable contact with someone to provide more detailed information about the tests or about cover crops—e.g., whom to call to learn how to adapt machinery, whom to call to identify incipient failure

Study design:
number of replications, presence of controls, rigor of controls, size of plots, etc.

Growing conditions:
environmental conditions prior to or during the tests—e.g., rainfall timing or amount, temperature

Inputs:
specific brands of products used or alternatives that might be used

Practices:
further information about practices used or about alternative practices or timing of practices

Non-yield results:
outcomes of the tests other than yields—e.g., weed control index, quality of cover crop

Long-term findings:
findings of trials over several (e.g., five) years

Statistics:
statistical descriptions of findings or estimates of generalizability of findings—e.g., coefficients of variance

Costs:
costs of specific inputs, total costs of cover crop methods and comparisons with costs of current and alternative methods

Profits:
net income derived from cover crop methods and comparisons with controls; also, net income likely with alternative cover crops

Problems:
problems encountered in tests or identifying and coping with potential problems associated with use of cover crops—e.g., how to anticipate cover crop failure, what to do if cover crops provide inadequate weed control

Risks:
information about potential yield losses if cover crops prove ineffective or if growing conditions do not match those experienced in tests or if procedures are modified

Advice:
observations or recommendations regarding how to implement technologies tested on own farm—e.g., adaptability to different soil types, slopes

Figure 2. Additional cues wanted categories and classification criteria.

a higher validity rating. The relevance scores were not associated with characteristics of either the farmers or their enterprises.

Validity cues identified

A simple count of the participants' marks (Table 4) shows that information about study design (mainly references to experimental controls and number of plots or fields) and comparative yield data were the most consistently marked cues. Many participants also marked various kinds of information about the production technologies used in the trials. A small group marked cues identifying how the trials were conducted and who sponsored them.

Correlating the participants' factor scores for the five cue groups with other measures reveals no statistically significant associations between the cues they used and their ratings of the trials' methodological validity or practicality (Table 5). There are few statistically significant relationships with farmer and enterprise characteristics; cultural-practice cues were used less often by those with larger farms and LGU degrees, while sponsorship cues were marked more often by those with more formal education and more cropland. Neither previous familiarity with cover crops nor length of farming experience was associated with choice of cues.

Additional cues desired

The participants would be more confident in the trials' validity if they not only were told more about the experimental design, but also were given more data that could help them assess the findings' poten-

Table 2. Rotated factor matrix of additional research-report cues desired.

	I	II	III	IV	V	VI
Growing conditions	***.766***	.101	.179	.104	.231	-.107
Non-yield results	***.668***	-.003	.064	-.075	-.015	.007
Advice	***.488***	.273	-.019	.146	-.175	.337
Risks	.110	***.791***	.088	.067	-.189	.108
Problems	.182	***.697***	.016	-.207	-.025	.113
Researcher name	-.171	***.509***	.111	.089	.141	-.328
Inputs	.001	-.036	***.891***	-.123	-.105	.026
Practices	.310	.311	***.777***	.038	.136	.062
Study design	.211	.032	-.213	***.788***	-.108	-.136
Statistics	-.465	-.054	.097	***.609***	.382	-.020
Long-term findings	.002	-.148	.083	***.574***	-.300	.460
Costs	.088	-.114	-.023	-.074	***.902***	.092
Profits	-.045	.105	.071	-.081	.177	***.855***

Table 3. Validity and practicality ratings: correlations with participant's personal and enterprise characteristics.

	Validity Score	Practicality Score
mean	13.2	8.0
standard deviation	4.7	4.9
Correlation with:		
Farm experience	.02	.03
Formal education	-.19	.01
LGU education	-.27*	-.08
Crop acres	.26*	-.18
Cover-crop familiarity	-.27*	.14
Practicality score	.27*	—

* $p < .05$

tial usefulness, such as costs and indicators of performance besides comparative yields (Table 4). However, there is only one statistically significant relationship between the participants' factor scores for the six groups of additional cues desired and their overall ratings of the trials' validity and practical relevance (Table 5); respondents who rated the trials more practical were more likely to call for additional design-related cues, perhaps to help make them more confident in the trials' methodological validity. Education was positively related to a desire for design-related cues; farming experience (which was slightly negatively correlated with education) showed an opposite association. Familiarity with cover crops was positively associated with a desire for information about costs.

Table 4. Research-report validity cues marked and additional research-report cues desired.

Cues Marked	Number	Percent
Cultural Practices		
Tillage operations	34	60.7
Timing	33	58.9
Planting methods	33	58.9
Equipment used	22	39.3
Field size	22	39.3
Study objectives	21	37.5
Any practice cue	45	80.4
Study Design/Results		
Yields	42	75.0
Study design	38	67.9
Chemical application	30	53.6
Any design cue	48	85.7
Inputs		
Chemical rates	36	64.3
Chemical names	30	53.6
Other inputs	25	44.6
Any input cue	44	78.6
Sponsorship		
Test sponsor	28	50.0
Test location	22	39.3
Test year	13	23.2
Any sponsor cue	34	60.7
Summary Advice		
Advice (study A)	20	35.7
Advice (study B)	18	32.1
Any advice cue	26	46.4

Cues Desired	Number	Percent
Conditions/Outcomes		
Non-yield results	28	50.0
Growing conditions	16	28.6
Advice	16	28.6
Any outcomes cue	37	66.1
Potential Problems		
Problems	13	23.2
Researcher name	11	19.6
Risks	5	8.9
Any problems cue	22	39.3
Technologies		
Inputs	15	26.8
Practices	13	23.2
Any technology cue	19	33.9
Study Design Specifications		
Study design	26	46.4
Long-term findings	24	42.9
Statistics	5	8.9
Any design cue	36	64.3
Costs	31	55.4
Profits	12	21.4

Table 5. Research-report validity cues identified and additional research-report cues desired: correlations of factor scores with participant's personal and enterprise characteristics.

	Farm Experience	Formal Education	LGU Education	Crop Acres	Cover-Crop Familiarity	Validity Score	Practicality Score
Cues Identified							
Practices	.11	-.14	-.24*	-.24*	.16	-.06	.09
Design	-.02	-.05	-.13	.01	-.01	-.08	.16
Inputs	-.15	.18	-.10	-.13	.06	-.11	-.08
Sponsorship	-.02	.24*	.13	.37**	.06	.17	-.02
Advice	.00	-.16	.01	.12	.13	.07	.07
Additional Cues							
Conditions	-.01	.16	-.11	-.04	-.06	.07	-.11
Problems	.08	-.12	-.19	-.05	.12	-.00	.18
Technology	-.22	.14	.14	.14	.16	-.06	.02
Design	-.33**	.41***	.26*	.01	.14	-.16	.29*
Costs	.06	.17	.18	-.18	.23*	-.18	-.03
Profits	-.03	.03	-.14	-.08	.00	-.15	-.20

* $p<.05$
** $p<.01$
*** $p<.001$

Summary Observations

Generalizability, relevance and plausibility in validity assessment

For many participants, the validity of the results depended not only on the experimental methods that produced them, but also on whether they considered the materials and field operations relevant to their own practices. Their frequent use of design-related cues implies that farmers also require that a study's results be properly arrived at and generalizable. On the other hand, they used technology and outcome cues almost as frequently.

These findings do not reveal the relative importance of generalizability and relevance in farmers' validity assessments. However, a reconstruction of the reasoning described by several participants suggests that research findings that pass both tests must also produce plausible results before a farmer will consider using them. In their accounts, these farmers suggested that if the crop yields in the trials had been implausibly high, they would have had less confidence in the studies' overall validity, regardless of their perceptions of the soundness of the methods used to measure those yields. On the other hand, they added that if the yields had been low enough to make the cover crop practices unprofitable, they would have judged them invalid on practical grounds.

The farmers' thresholds for plausible yields no doubt vary according to their own yields, their experience with cover crops, whether they believe alternative technologies can produce yields equal to conventional practices, and many other factors. However, each farmer clearly began the validation process with some expectation of how much an acre of corn or soybeans raised with cover crops would produce. Because the reported yields were plausible, that is, comparable with average local yields, the farmers then attempted to infer their validity from the report's design-related, technology-related, and source-identifying cues. Although several farmers reported that the chemicals, crop varieties and individual field operations in the trials were in common use and thus were plausible, they almost all judged that the overall regime, with its multiple, precisely timed tillage operations, was utterly implausible. This reduced their assessments of the studies' potential relevance, even though they had confidence in the bulletin's source and the research design, and therefore considered the study to be methodologically valid. Thus the farmers found the trials to be good science but bad farming; no improvement in methodology or design information, only an implausible increase in yields, was likely to alter their assessment.

Plausibility, because it affects farmers' assessments of both methodological validity and relevance, furnishes a threshold or limiting criterion for streamlining the validation process. Further study should explore the bounds of plausibility and the information or cues that farmers use to assess plausibility in different contexts. Com-

ments of farmers in this study suggest that for at least some of them, the trials' outcomes and the kinds and scales of technologies that produced them provided plausibility cues.

The credibility of a research report's sponsor or source may furnish a shortcut for more detailed validity assessment. It enables farmers summarily to regard as plausible a study design, farming operation, or finding sponsored or reported by credible sources. Conversely, farmers can discount research and recommendations associated with less credible ones. In this study, for example, only four farmers marked the sample bulletin's CES logo as a validity cue, but 17 hinted at this in later conversation, in comments such as "I guess they wouldn't put out anything that they didn't think was true" and "They must think it was done OK." The CES logo and university sanction may have enhanced the credibility of the cover crop tests despite the farmers' own criticisms of the farming and research methods used in the tests.

Implications, qualifications and suggestions for research and practice

The cataloguing of cues is a basic step toward a fuller elaboration of what farmers look for in research reports. Future studies might also manipulate the cues presented in a document to identify more clearly how each influences farmers' validity evaluations. For example, different versions of a document might report various numbers of replications or different kinds and number of tillage operations. They might present their findings in different formats, offer differing information about costs, or include/not include pictures of practices in use. Studies are also needed in a wider range of contexts, such as research-based communications about livestock production, farm management, and farm policy analysis, or with farmers for whom alternative practices are more plausible. Future studies should also strive to develop more sophisticated measures of perceived validity and practicality than those used here.

Farmers believe that findings produced by non-scientists or by larger-scale or less rigorously controlled evaluations of technologies can be generalizable and useful. However, findings produced by alternative sources or methods must also meet at least some formal and methodological criteria of academic science before farmers will judge them to be valid. Farmers say they ultimately want results from other farmers' applications of farming practices, but they also appear to be socialized to look for indicators (such as the CES logo or familiar statistics) to help them decide that those results were derived by sound scientific practice. Cooperation by Extension staff and university faculty members could add these important validity cues to findings of farmer-directed research sponsored by local and state alternative agriculture groups. In working with farmer groups, however, academic scientists must not impose their own validity standards on the design or reporting of farmer-run research.

By illustrating the range of information that farmers use to assess the validity of agricultural research, the findings also suggest ways to improve research reports, along with research design and record keeping, so that the results of both on-farm and institutional research can be communicated more widely and effectively. Much of what the farmers in this study said they want fits under the label *decision data*: information, in common language, about costs and potential problems, yields, performance (such as weed control ratings), and profitability with standard technologies. A few participants asked for what essentially is a sensitivity analysis of profits with the new technology under varying input costs and commodity prices. Others suggested they rarely give much attention to research that does not summarize farmer experience with a technology.

This study is inconclusive regarding whether farmers, as an audience for production research findings, can or should be segmented according to the cues they use in validity assessment. It is not likely that a practical segmentation scheme will emerge either easily or quickly. Therefore, effective communication of the results of non-traditional research should include a broad range of potential validity cues.

Yet of articles and bulletins reporting applied agricultural research results and giving recommendations based on them, few furnish the full range of decision data the farmers in this study said they want: detailed information about immediate, local usefulness along with a full range of research design cues that enable them to evaluate a study's validity and usefulness for their own farms. On-farm and farmer-run research can be conducted on a great variety of sites. Therefore, non-design cues that describe a study's ecological and historical context (and perhaps philosophical context as well) would be especially important for farmers and others attempting to evaluate and make sense of such studies' results. A report of on-farm research—or of research from conventional research plots—should describe not only the study design, the materials and practices used, and the outcomes, but also the growing conditions before and during the study, the field's management and yield history, unanticipated difficulties and other decision data. Moreover, it should organize that data in ways that help farmers incorporate their own contingencies when they interpret the findings.

Acknowledgements: Funding for this research was provided by the Illinois Agricultural Experiment Station, Hatch Project 04-303.

References

1. Ajzen, I. 1977. Intuitive theories of events and the effects of base rate information on prediction. J. Personality and Social Psychology 35:303-314.
2. Berlo, D.K., J.B. Lemert, and R.J. Mertz. 1970. Dimensions for evaluating the acceptability of message sources. Public Opinion Quarterly 33:563-576.
3. Borgida, E., and R.E. Nisbett. 1977. The differential impact of abstract vs. concrete information on decisions. J. Applied Social Psychology 7:258-271.
4. Cacioppo, J.T., R.E. Petty, and K.J. Morris. 1983. Effects of need for cognition on message evaluation, recall, and persuasion. J. Personality and Social Psychology 45:805-818.
5. Delia, J.G. 1976. A constructivist analysis of the concept of credibility. Quarterly J. Speech 62:361-375.
6. Dervin, B. 1983. Information as a user construct: The relevance of perceived information needs to synthesis and interpretation. In S.A. Ward and L.J. Reed (eds). Knowledge Structure and Use: Implications for Synthesis and Interpretation. University Press, Philadelphia, Pennsylvania. pp. 153-183.
7. Francis, C.A., P.E. Rzewnicki, A. Franzluebbers, A.J. Jones, E.C. Dickey, and J.W. King. 1989. Closing

the information cycle: Participatory methods for on-farm research. Paper presented to conference on Farmer Participation in Research for Sustainable Agriculture, Fayetteville, Arkansas.
8. Gaziano, C., and K. McGrath. 1986. Measuring the concept of credibility. Journalism Quarterly 63(3):451-462.
9. Gillespie, G.W., Jr., and F.H. Buttel. 1989. Farmer ambivalence toward agricultural research: An empirical assessment. Rural Sociology 54(3):382-408.
10. Harte, T.B. 1972. The Effects of Initial Attitude and Evidence in Persuasive Communications. Ph.D. thesis. Dept. of Speech Communication, Univ. of Illinois, Urbana.
11. Hecht, S.B. 1988. The evolution of agroecological thought. In M. Altieri (ed). Agroecology: The Scientific Basis of Alternative Agriculture. Westview Press, Boulder, Colorado. pp. 1-22.
12. Hovland, C., and W. Weiss. 1951. The influence on source credibility on communication effectiveness. Public Opinion Quarterly 15:635-650.
13. Illinois Dept. of Energy and Natural Resources. 1991. 1990 Sustainable agriculture demonstration grant program results. Springfield.
14. Jackson, W. 1987. Altars of Unhewn Stone. North Point Press, San Francisco, California.
15. Kahneman, D., and A. Tversky. 1973. On the psychology of prediction. Psychology Review 80:237-251.
16. Kline, J.A. 1969. Interaction of evidence and readers' intelligence on the persuasiveness of short messages. Quarterly J. Speech 55:407-415.
17. Kloppenburg, J.R., Jr. 1991. Social theory and the de/reconstruction of agricultural science: Local knowledge for an alternative agriculture. Rural Sociology 56(4):519-548.
18. Kruglanski, A.W. 1980. Lay epistemologic — process and contents: Another look at attribution theory. J. Personality and Social Psychology 87:70-87.
19. Kruglanski, A.W. 1989. Lay Epistemics and Human Knowledge. Plenum, New York, N.Y.
20. Kruglanski, A.W., and T. Freund. 1983. The freezing and unfreezing of lay-inferences: Effects on impressional primacy, ethnic stereotyping, and numerical anchoring. J. Experimental Social Psychology 19(5):448-468.
21. Kruglanski, A.W., and O. Mayseless. 1988. Contextual effects in hypothesis testing: The role of competing alternatives and epistemic motivations. Social Cognition 6:1-20.
22. Mayseless, O., and A.W. Kruglanski. 1987. What makes you so sure?: Effects of epistemic motivations on judgmental confidence. Organizational Behavior and Human Decision Processes 39:162-183.
23. McQuarrie, F.O. 1984. The Effects of Inserting Research-based Information into a Standard Goal Setting Process. Ph.D. thesis. Dept. of Psychology, Pennsylvania State Univ., University Park.
24. Molnar, J.J., P.A. Duffy, K.A. Cummins, and E. Van Santen. 1992. Agricultural science and agricultural counterculture: Paradigms in search of a future. Rural Sociology 57(1):83-91.
25. Petty, R.E., and J.T. Cacioppo. 1984. The effects of involvement on responses to argument quantity and quality: Central and peripheral routes to persuasion. J. Personality and Social Psychology 46:69-81.
26. Petty, R.E., S.E. Harkins, and K.D. Williams. 1980. The effects of group diffusion or cognitive effort on attitudes: An information-processing view. J. Personality and Social Psychology 38:81-92.
27. Petty, R.E., J.T. Cacioppo, and R. Goldman. 1981. Personal involvement as a determinant of argument based persuasion. J. Personality and Social Psychology 41:847-855.
28. Postman, N. 1992. Technopoly: The Surrender of Culture to Technology. Knopf, New York, N.Y.
29. Restivo, S.R., and J. Loughlin. 1987. Critical sociology of science and scientific validity. Knowledge: Creation, Diffusion, Utilization 8(3):486-508.
30. Rzewnicki, P.E., R. Thompson, G.W. Lesoing, R.W. Elmore, C.A. Francis, A.M. Parkhurst, and R.S. Moomaw. 1988. On-farm experiment designs and implications for locating research sites. Amer. J. Alternative Agric. 3(4):168-173.
31. Suppe, F. 1987. The limited applicability of agricultural research. Agric. and Human Values 4(4):4-14.
32. UWEX. 1989. Management guides for sustainable agriculture: Controlling weeds with cover crops in sustainable agriculture. Univ. of Wisconsin Cooperative Extension Service, Madison.
33. Walter, G.L. 1991. Extensions of extension: Socialization and credibility constraints on private crop advisors. J. Applied Communications 75(2):30-41.

Farm Profiles Invited

For its new department on alternative agriculture profiles, the *AJAA* welcomes short articles describing farmers who have adopted interesting alternative practices. The articles should include five elements: a brief description of the farm; the problems that made the farmer look for an alternative approach and the reasons why the alternative seemed plausible; a summary of the basic principles behind the alternative (possibly in a sidebar if it interrupts the flow of text); a discussion of how well the alternative has worked; and a discussion of the applicability of the alternative for other farms. The length should be 1500 to 2000 words.

Submissions must be accompanied by a release, signed by the farmer, giving permission for this material to be published in the *American Journal of Alternative Agriculture*. Vol. 3, No. 4, of the *AJAA* has a further description of the department (page 188); or query the editor for further information. Send submissions to the Editor, *AJAA*, 9200 Edmonston Road, Suite 117, Greenbelt, MD 20770-1551.

Letters To The Editor Invited

The *AJAA* welcomes letters, short or long, commenting on articles in this journal or sharing ideas likely to be of interest to other *AJAA* readers. Since our space is limited, we do reserve the right not to publish all letters or, at times, to publish only excerpts from them. To take part in this exchange of ideas, write to: Editor, *AJAA*, 9200 Edmonston Road, Suite 117, Greenbelt, MD 20770-1551.

INSTITUTE NEWS

Wallace Institute Board Elects Five New Members

The Wallace Institute's Board, at its mid-year meeting held recently in Berkeley Springs, W.V., elected five new members who will start their terms in March, 1994. On the day preceding the meeting, the Board also toured the organic-certified farm of Board member Ward Sinclair, and the dairy farm of Richard Mosemann, who uses an innovative rotational grazing system.

The new Board members are: **Dr. Cornelia Butler Flora**, Professor and Head, Department of Sociology, Virginia Polytechnic and State University, and former Assistant Professor at Kansas State University; **Dr. James William Gibbons**, owner of a family-run small fruit and vegetable farm in Ozark, AR, and former Senior Rice Scientist, Centro International de Agricultura Tropica, Colombia, South America; **Sister Esther Nickel** of the Religious Sisters of Mercy, Jackson, MN; Ph.D. in agronomy, and manager of a student learning center for practical farm experience; **Kenneth J. Taylor**, Executive Director of Minnesota Food Association, and former Chair, North Central Region Administrative Council, USDA SARE Program; and **Gregory C. Watson**, Eastern Regional Director, The Nature Conservancy, and former Commissioner, Massachusetts Department of Food and Agriculture.

Members of Wallace Institute's President's Council Named

Kate L. Clancy, President of the Wallace Institute, has announced the members of the 1993-1994 President's Council, formed three years ago to provide guidance and support for Wallace Institute activities in promoting a more sustainable agricultural system in the United States and abroad. Members are: Dr. Jill Shore Auburn, University of California, Davis; Dr. Charles Benbrook, Benbrook Consulting Services; Norman A. Berg, Washington Representative, Soil and Water Conservation Society; Hon. Bob Bergland, Executive Vice President and General Manager, National Rural Electric Cooperative Association; Hon. George E. Brown, Jr., U.S. House of Representatives; Ron Ellermeier, farmer, Glenvil, NE; Robert Gray, Resource Management Consultants; Ralph Grossi, President, American Farmland Trust; Dr. R. Jim Hildreth, Elmhurst, IL; Ms. Dana Jackson, Minnesota Food Association; Dr. Dennis R. Keeney, Director, Leopold Center, Iowa State University; Dr. Fred Kirschenmann, Kirschenmann Family Farms, Windsor, N.D.; Hon. Patrick J. Leahy, U.S. Senate; Dan Martin, Director, World Environment and Resources Program, MacArthur Foundation; Dr. Ned S. Raun, Stillwater, OK; Ronald L. Rosmann, farmer, Harlan, IA; R. Neil Sampson, Executive Vice President, American Forestry Association; Edward Sills, Pleasant Grove Farms, CA; Dr. Karl N. Stauber, Vice President—Program, Northwest Area Foundation; Dr. David G. Topel, Dean, College of Agriculture and Director of Experiment Station, Iowa State University; and Dr. Stephen Viederman, President, Jessie Smith Noyes Foundation.

Committees Elected at National Sustainable Ag Council's First Meeting

The election of four standing committees was among the actions taken at the first meeting of the National Sustainable Agriculture Advisory Council, held recently in Omaha, Nebraska. The Council spent most of its first meeting day on a sustainable agriculture farm, research, and education tour, including a visit to the farm of Ron and Marie Rosmann in Harlan, Iowa; it then participated in a sustainable agriculture forum, which included discussions about the Southern Sustainable Agriculture Working Group and the Agriculture Conservation and Environmental Center. The second day's activities included a review of proposed USDA policy on sustainable agriculture, a SARE program overview, and reports on selected Regional SARE projects.

Members of the four standing committees are: **Executive Committee:** Chair, James E. Horne, Oklahoma; Raymond F. Eid, Delaware; Frederick L. Kirschenmann, North Dakota; Kate Burroughs, California; and Ben Burkett, Mississippi. **Committee on Strategic Planning:** Chair, Frederick L. Kirschenmann; Robert B. Anderson, Pennsylvania; Raymond F. Eid; Jackie P. Judice, Louisiana; and Tim Rose, Kansas. **Committee on Recommendations and Reporting:** Chair, Kate Burroughs; Leland L. Leachman, Montana; Lorraine Merrill, New Hampshire; and Sandra Schlicker, Washington, D.C. **Committee on Communications:** Chair, Ben F. Burkett; Michael Brusko, Pennsylvania; Stanley E. Howell, Illinois; and Madeline Mellinger, Florida. According to regulations released in May, 1992, the Council is a statutory committee authorized by the Food, Agriculture, Conservation, and Trade Act of 1990; it was established to "advise the Agriculture Secretary in matters related to the SARE Program."

Showcase of Sustainable Agriculture Information and Educational Materials, 79 pages, is $4.95 from Sustainable Agriculture Publications, Hills Building, Room 12, University of Vermont, Burlington, VT 05405.

National Directory of Organic Wholesalers is $34.95 plus $4 shipping/handling (California residents add $2.53 sales tax) from Community Alliance with Family Farmers, PO Box 464, Davis, CA 95617; 1-800-852-3832.

Assessment of 1992 Wisconsin Atrazine Rule (Ag30) is $5 from College of Agricultural and Life Sciences, University of Wisconsin, 420 Agriculture Hall, 1450 Linden Drive, Madison, WI 53706; (608)262-6049.

Sustainable Agriculture Resources and Information Directory, Minnesota 1993 is available from Minnesota Department of Agriculture, Energy and Sustainable Agriculture Program, 90 West Plato Boulevard, St. Paul, MN 55107; (612)296-7673.

Organic Market Guide: New Jersey Region 1993-94, 192 pages, is $9.95 plus $2.50 postage from Northeast Organic Farming Association of New Jersey, 31 Titus Mill Road, Pennington, N.J. 08534; (609)737-6848.

Bromacil as a Ground-Water Contaminant, a report prepared for the United Mine Workers of America, is available from Disposal Safety Incorporated, 1660 L St., NW, #314, Washington, D.C. 20036; (202)293-3993.

Agricultural Research Alternatives, by William Lockeretz and Molly D. Anderson, 248 pages, is $30 from University of Nebraska Press, PO Box 880520, Lincoln, NE 68588-0520.

Wetlands Deskbook, a guide to wetlands laws and regulations, 663 pages, is available for $85 from Environmental Law Institute, 1616 P St., NW, #200, Washington, D.C. 20036; call Dwayne Johnson, (202)939-3844.

How to Make Compost: An Instructional Video, produced by the University of California's Agroecology Program, is $15, checks payable to UC Regents, from Agroecology Program, University of California, Santa Cruz, CA 95064, Attn: Compost Video; (408)459-4140.

New Policy Directions to Sustain the Nation's Water Resources: Summaries of the Environmental and Energy Study Institute's Water Briefing Series, 51 pages, is $25 from EESI, 122 C St., NW, #700, Washington, D.C. 20001; (202)628-1400.

The Economics of Sustainable Agriculture: American and Bulgarian Perspectives, 71 pages, a summary of a 1991 National Academy of Sciences workshop, is available from Office of Central Europe and Eurasia, National Research Council, 2101 Constitution Ave., NW, Washington, D.C. 20418; (202)334-2644.

Thompson Farm On-Farm Research Field Day is More Than That

Few followers of alternative and sustainable agriculture do not know about Dick and Sharon Thompson's farm in Boone, IA, and their annual field days. At this year's event, held recently, participants saw and discussed results of continuing on-farm research on everything from ridge tillage, cover crops, corn varieties, manuring strategies, and rotational grazing, to swine production without antibiotics.

The results are available in the *Thompson On-Farm Research* 1993 report, published this year with support from the Wallace Institute. Copies are $10 from Thompson On-Farm Research, 2035 190th Street, Boone, IA 50036, as are copies of *Walking the Journey: Sustainable Agriculture That Works* ($22), a 22-minute video which explains the Thompsons' operation and was professionally produced by Iowa State University Cooperative Extension.

The research results tell only part of the Thompson story. Practical Farmers of Iowa is a grassroots organization formed in 1985 by the Thompsons and a handful of other farmers who wanted to learn how to farm in ways that are both environmentally beneficial and profitable. It now has 450 members, including 28 farmers doing on-farm research. Rather than competing with Iowa State University researchers, PFI works closely with them, and "may be the first grassroots sustainable farmers group to have a contractual agreement with a Land Grant Institution," according to the Thompson research report.

EPA To Expand Screening Tests on Food Crop Pesticides

In response to the National Academy of Sciences' report, *Pesticides in the Diets of Infants and Children*, the EPA plans to expand the screening tests for all pesticides used on food crops. The new tests will include an expansion of neurotoxicity testing to cover motor impairment, tremors, and paralysis; immune system toxicity that would make people more vulnerable to illness; and endocrinology testing for effects on the hormone system. EPA will also explore the re-establishment of an incident monitoring system to obtain a clearer picture of cases on pesticide poisoning.

Among the steps EPA will take in conjunction with USDA and the Food and Drug Administration to reduce the use of pesticides in food production are increased efforts to promote sustainable agriculture and integrated pest management practices, and changes in the regulatory program to stimulate incentives for registration or licensing of safer pesticides.

Barriers to low-input agriculture adoption: A case study of Richmond County, Virginia

Penelope L. Diebel, Daniel B. Taylor, and Sandra S. Batie

Abstract. *We coupled a nonlinear mathematical programming model with sensitivity analysis and evaluated some economic barriers to adoption of low-input agriculture by farmers in Richmond County, Virginia. Collection of primary data made the model more realistic. We analyzed potential barriers to adoption, including poultry litter price, yields, labor requirements, and variable input costs. We found the adoption of low-input practices to be sensitive to the price of poultry litter and relatively insensitive to yields, labor requirements, and variable costs. However, when several of these barriers are combined, the model predicts that farmers would use conventional practices. Therefore analysis of the farm as a system rather than practice by practice is important when identifying the effects of economic barriers.*

Key words: alternative agriculture, organic farming, poultry litter

Introduction

Farmers may adopt low-input agriculture for a combination of reasons. Environmentally concerned farmers may view low-input agriculture as a corrective measure for conventional farming's damage to soil, water, air, and wildlife. Farmers may adopt low-input agriculture to obtain lower production costs through more appropriate timing of pesticide applications and reducing the amount and number of pesticides used. The cost of substituting labor, and particularly management time, for petroleum-based products under low-input agricultural practices has not been estimated accurately but may be acceptable for farmers. Despite the advantages of reduced health hazards, improved environmental quality, and reduction of costly purchased inputs, low-input agriculture has not been adopted on a wide scale.

Much of the current research on low-input agriculture examines possible barriers to its adoption, including yield reductions, higher labor requirements, higher variable costs, and the limited availability of alternative sources of nitrogen. The barrier most commonly cited is the federal agricultural commodity programs (Norris, 1988), which support only certain crops, encourage high yields, and restrict the possibility of more complex rotations (Young and Goldstein, 1988; Fleming, 1987; Buttel et al., 1986; Daberkow and Reichelderfer, 1988).

Although some possible barriers to low-input agriculture adoption are easily identified, there are few analyses to support statements about the strength or existence of these barriers. Exceptions include a 5-year study by Lockeretz et al. (1984), which compared organic and conventional yields and production costs across five states. In all five years, production was lower on organic farms, but costs of production also were lower. On average, the savings in operating expenses offset the lower value of production, and the net incomes per hectare were about equal for the low-input and conventional systems. Also, Dabbert and Madden (1986) studied the transition from conventional to low-input agriculture systems. Their linear programming analysis found that even without imposing severe yield penalties, net income fell by 13% in the first year of the transition. Net income rose in the following 5 years, leveling off at approximately 7% below the conventional system. In addition, Madden (1988) stated that adoption of low-input agriculture on some large farms might be limited by scarce managerial time.

However, these studies do not adequately analyze many hypothesized economic barriers to low-input agriculture adoption. Our objectives in this study were to learn which agricultural practices maximize profits in Richmond County, Virginia when low-input alternatives are available, and to evaluate how sensitive the adoption of low-input agriculture is to some potential barriers. For the purposes of this article, agriculture is represented by a spectrum of production practices that include conventional pesticide-intensive practices and completely organic practices with no synthetic pesticides. The term low-input agriculture is defined as a production activity that uses pesticides or manufactured nitrogen fertilizer at or below Extension Service recommended rates.

Kansas Agricultural Experiment Station Contribution No. 93-398-7, Kansas State University, Manhattan, KS 66506. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily express the views of the sponsors.

Penelope L. Diebel is Assistant Professor, Department of Agricultural Economics, Kansas State University, Manhattan, KS 66506-4011; Daniel B. Taylor is Associate Professor, Department of Agricultural Economics, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0401; and Sandra S. Batie is Elton R. Smith Professor of Food and Agricultural Policy, Department of Agricultural Economics, Michigan State University, East Lansing, MI 48824-1039.

Methods

Richmond County is the second largest county in the Coastal Plain area of Virginia. Nearly 68% of Richmond County's farmland is cropland (U.S. Department of Commerce, 1989). The largest portion of cropland is planted in soybeans, corn, and small grains. There are approximately 148 farms in Richmond County; however, most operators manage more than one farm (U.S. Dept. of Commerce, 1989). The area has livestock, but livestock production is not considered a major industry. Little more than 7% of cropland is grazed (U.S. Dept. of Commerce, 1989).

A multi-period (15 years, beginning in 1988), mathematical programming model determined the profitable agricultural practices for Richmond County and the effect of potential barriers to low-input agriculture adoption. The model contained 4,745 equations and 6,976 variables. Figure 1 contains the general equations in the model. The objective function of the model maximized net returns over variable costs for a 15-year period, starting in 1988, using a 6% discount rate. The 6% discount rate is similar to that recommended by other experts: Barry (1980) suggested a 5% discount rate to reflect real returns to capital assets in agriculture; Randall (1987) recommended a real discount rate of 4 to 6% when calculating the present value of natural resources.

The model calculated crop revenues separately for land enrolled in the commodity programs and land not in them. Two accounting constraints kept cropland at or below the 32,318 acres available in Richmond County and constrained total land in the three set-aside programs: the Acreage Reduction Program (ARP), Conservation Reserve Program (CRP), and Virginia buffer strip requirements. We set the ARP constraint at the 1988 required set-aside of 10% of corn, wheat, and barley base acres. The CRP constraint was initially set at the 1989 levels of 145 acres in trees and 1,429 acres in grassland, and then was reduced starting in year 9 as grassland CRP contracts expired. CRP land planted to trees was not returned to crop production, and no new cropland was enrolled in the CRP program. In 1989, the Chesapeake Bay Local Assistance Board required a minimum 25 foot buffer strip between agricultural land and the Chesapeake Bay or its major tributaries. On the basis of Virginia Geographic Information System estimates, about 190 acres of cropland were set aside as 25 foot buffers in Richmond County.

The model also included nonlinear equations that calculated the moving averages of yield and base acres for the federal commodity programs. These equations then constrained the crop acreage base and program payment yield. The commodity programs restricted the crop acreage base each year to the average of acres planted the preceding 5 years. They also limited the annual farm program yields to the average yield during the previous 5 years.

The model assumes perfect knowledge of future prices, available labor, and yields. Also, we pooled farm operator labor across the county. Labor could be purchased when all on-farm operator labor was used. We valued both types of labor at $4.50/hr. The model did not allow for a transition to the low-input activities, during which yields may decrease, because field data on the transition were unavailable. Initially, therefore, yields in the model did not vary among activities. However, we examined this assumption of equal yields as part of the sensitivity analysis. The model used adjusted data from 1970 through 1985 for yields and prices; thus, these aspects of the activities varied across the 15 years of the model. We detrended crop yields by regressing them on a polynomial in t (time) to remove the effects of technological progress. The residuals of this regression represented yield variations from weather and economic conditions. The residuals were then added to 1988 yields to project 15 years forward, assuming the same conditions as 1970-1985. Price variation then matched yield variations and were adjusted to 1988 dollars.

A personal survey of 38 Richmond County farm operators, conducted in the summer of 1989, (approximately 47% of the full-time farmers in the county) provided information on agronomic practices (Giuranna et al., 1991). The Richmond County Extension Agent helped in our selection of farm operators. The farmers selected were not statistically representative. They only provided information on the spectrum of farming practices employed in the county (K.J. Liddington, Virginia Cooperative Extension Service Agent, Agriculture/Unit Director, personal communication, 1989). In addition, the personal interviews gave us a better estimate of machinery availability, labor availability, the economic situation, and the attitudes of Richmond County farm operators. Of the operators surveyed, 61% planted more than half their cropland in three cash grains: corn, wheat, and soybeans (Hwang, 1990). Farm operations, including machinery, tillage practices, and nutrient and pesticide levels, were fairly homogeneous. On the basis of this survey, we identified four primary crop rotations. The pesticides used in each of these rotations consisted mainly of herbicides; the level of use could be considered as "moderate," as farmers tended to follow Extension Service recommendations.

We then constructed thirty-four alternative production activities using the four identified rotations. Differing fertilization rates and application methods, nitrogen sources, types and application rates of pesticides, and non-chemical weed control practices were added to these initial rotations. The construction of the model's activities incorporated the advice of the Richmond County Farm Management Extension Agent (Liddington, personal communication, 1989) and a Cooperative Extension Service weed specialist (S.E. Hagood, Virginia Polytechnic Institute and State Univ., personal communication, 1990). Summaries of the production activities appear in Table 1.

Crop requirements dictated the amount of nitrogen used within each production activity (Liddington, personal communication, 1989; Perkinson, 1989). The model accounts for four sources of nitrogen: commercial nitrogen, poultry litter, crop residues, and nitrogen fixed by legume crops. When determining nitrogen application rates for all activities, we calculated the credits for the nitrogen available from previous crop residues, including legumes if used.

We estimated the credit for nitrogen in crop residues from decay rates and total nitrogen in the residue (Bartholomew, 1965; Gilbertson, 1979; Norris, 1988). Critical to using nitrogen was the incorporation of residues (Pieters and McKee, 1938; Bartholomew, 1965; for the calculations see Diebel, 1990). Commercial nitrogen

Objective Function—Maximize Net Returns Over 15 Years:

$$Max \sum_{t=1}^{15} \left(\left(\sum_{a=1}^{34} [I_{at} X_{at}] + \sum_{a=1}^{34} [I_{at} Z_{at}] + \sum_{a=1}^{34} [G_{at} Z_{at}] - \sum_{k=1}^{3} [PP_{kt} SET_{kt}] \right) / (1+r)^t \right)$$

Annual Cropland Accounting Constraint:

$$\sum_{a=1}^{34} (X_{at} + Z_{at}) + \sum_{k=1}^{3} SET_{kt} \leq A \qquad \text{for } t=1...15$$

Annual Set-Aside Land Accounting Constraint:

$$(SET_{kt}) = B_{kt} \qquad \text{for } t=1...15,\ k=1...3$$

Annual Net Returns Accounting Constraint:

$$\sum_{c=1}^{7} \left[\left(P_{ct} Y_{cat} - \sum_{i=1}^{8} N_{ica} - \sum_{j=1}^{15} C_{jca} - L_{ca} \right) \theta_{ca} \right] - V_a = I_{at} \qquad \text{for } t=1...15,\ a=1...34$$

Annual Commodity Program Payment Accounting Constraint:

$$\sum_{c=1}^{7} [(T_{ct} - P_{ct})\, Q_{ct}\, \theta_{ca}] = G_{at} \qquad \text{for } t=1...15,\ a=1...34$$

Annual Average Yield Accounting Constraint:

$$\sum_{a=1}^{34} \left(\left[\sum_{c=1}^{7} \theta_{ca} Y_{cat} (X_{at} + Z_{at}) \right] \left[\sum_{c=1}^{7} \theta_{ca} (X_{at} + Z_{at}) \right]^{-1} \right) - F_{ct} = 0 \qquad \text{for } t=1...15$$

Five-Year Average Base Yield Constraint:

$$\sum_{v=1}^{5} \frac{1}{5} F_{c,\, t-v} - Q_{ct} = 0 \qquad \text{for } t=6...15$$

Five-Year Average Base Acreage Constraint:

$$\sum_{v=1}^{5} \frac{1}{5} \left[\sum_{a=1}^{34} \left(\sum_{c=1}^{7} \theta_{ca} Z_{a,\, t-v} \right) \right] \geq \sum_{a=1}^{34} \left(\sum_{c=1}^{7} \theta_{ca} Z_{at} \right) \qquad \text{for } t=6...15$$

Where:

t = index of time, t=1...15;
c = index of crops, c=1...7;
a = index of production activity, a=1...34;
i = index of nutrients, i=1...6;
j = index of chemicals, j=1...15;
k = index of set-aside program, k=1...3; where 1=Conservation Reserve Program, 2=Buffer Strip Program, 3=Acreage Reduction Program;
r = discount rate;
θ_{ca} = the percentage of a composite acre production activity a producing crop c;
I_{at} = gross income from crop sales (dollars);
X_{at} = acreage under activity a, not in the commodity program (acres);
Z_{at} = acreage under activity a, in the commodity program (acres);
G_{at} = income from government commodity program payments (dollars per acre);
PP_{kt} = variable costs for land in Acreage Reduction Program, Conservation Reserve Program, or Virginia's Buffer Strip Program (dollars per acre);
SET_{kt} = acreage in the Acreage Reduction Program, Conservation Reserve Program, or Virginia's Buffer Strip Program (acres);
A = total cropland availability (32,318 acres);
B_{kt} = allowable land enrollment in the Acreage Reduction Program, Conservation Reserve Program, or Virginia's Buffer Strip Program (acres);
P_{ct} = crop prices (dollars per bushel);
Y_{cat} = crop yields (bushels per acre);
N_{ica} = nutrient costs (dollars per pound);
C_{jca} = chemical costs (dollars per pound);
L_{ca} = labor costs (dollars per hour);
V_a = other variable costs (dollars per acre);
T_{ct} = commodity program target prices (dollars per bushel);
Q_{ct} = five year yield averages for commodity program payments (bushels per acre);
F_{ct} = crop yield average on all acres (bushels per acre).

Figure 1. General Equations in the Economic Model (See Diebel [1990] for more detail).

Table 1. Summary description of cropping activities available in the mathematical model.[1]

Production Activity[2]	Crop Rotation[3]	Pesticide/Nutrient Application Level	Unavailable Pesticides
1[4],1L	C/SG-DC (2-yr)	medium	none
2,2L	C/SG-DC (2-yr)	high	none
3,3L	C/SG-DC (2-yr)	low	none
4	C/SG-DC (2-yr)	medium	none
5L	C/SG-DC (2-yr)	organic	all
6,6L	C/SG-DC (2-yr)	medium	atrazine
7,7L	C/SG-DC (2-yr)	medium	metolachlor
17,17L	C/SG-DC (2-yr)	medium	paraquat
8,8L	C/SG-DC-Rye (2-yr)	medium	none
9,9L	C/SG-DC-Rye (2-yr)	medium	atrazine
10,10L	C/SG-DC-Rye (2-yr)	medium	metolachlor
11L	C/SG-DC-Rye (2-yr)	organic	all
18,18L	C/SG-DC-Rye (2-yr)	medium	paraquat
12,12L	C/SG-DC/FS/SG-DC (4-yr)	medium	none
13,13L	C/SG-DC/FS/SG-DC (4-yr)	medium	atrazine
14,14L	C/SG-DC/FS/SG-DC (4-yr)	medium	metolachlor
19,19L	C/SG-DC/FS/SG-DC (4-yr)	medium	paraquat
15,15L	C/SG-DC-Mix (2-yr)	medium	none
16L	C/SG-DC-Mix (2-yr)	organic	all

[1] See Diebel (1990), Appendix B.1, for a more detailed description of production activities.
[2] "L" with the activity number indicates that poultry litter was used as the source of nitrogen, otherwise activities with the same number are identical.
[3] C=corn; SG=small grains (wheat and barley); DC=double-cropped soybeans; FS=full season soybeans; Mix=rye and crimson clover.
[4] Production Activity 1 is considered the conventional activity for Richmond County, Virginia.

or poultry litter applications provided the remaining nitrogen required by the crop.

An activity having the suffix L used poultry litter as its source of nitrogen; the litter was shipped from the Shenandoah Valley, approximately 154 miles away. The activity's number indicates a crop rotation and its attendant pesticide and nutrient regimes. Therefore, Activities 1 and 1L were the same, except that Activity 1L used poultry litter as an organic source of nitrogen, whereas Activity 1 used commercial nitrogen fertilizer. An activity using poultry litter did not necessarily use low or zero levels of pesticides. For example, Activity 14L used a conventional amount of pesticides but used poultry litter as a nitrogen source. There were three organic activities: 5L, 11L, and 16L. Organic activities used poultry litter as their nitrogen source, increased cultivations for weed control, and no pesticides.

At the time of this study, poultry litter disposal was a growing concern in Virginia. Napit (1990) and Norris (1988) examined the potential for transporting litter to regions that have few local sources of animal manures. Poultry litter, however, should not be considered as the only possible organic source of nitrogen. Use of cattle manure is possible, as is the use of purchased organic fertilizers derived from composted plant material. The use of organic inputs does not imply there are no possible negative environmental impacts. Excessive or poorly timed applications of organic sources of nitrogen can result in nitrogen being carried in runoff and groundwater, just as with commercial inorganic fertilizer (Diebel, 1990; Diebel et al., 1992).

Two rotations include an aerially seeded winter cover crop that not only controls soil erosion but also can provide significant levels of nitrogen to the following crop. One rotation uses winter rye, which serves as a storage crop for organic nitrogen that is easily released when the crop is plowed under (Williams and Wicks, 1978). The other uses crimson clover, a legume, mixed with winter rye. Legumes are a well known source of organic nitrogen when plowed under (Doran et al., 1987; Power, 1987a,b; Frye and Blevins, 1989).

We used the General Algebraic Modeling System (GAMS) to solve the mathematical programming model in this study (Brooke et al., 1988). GAMS is adapted to interact with MINOS 5.2 (Murtagh and Saunders, 1987) to solve nonlinear models.

Results and Discussion

First, the model calculated a profit-maximizing solution called the "unrestricted scenario." Second, we analyzed the sensitivity of the unrestricted scenario to our assumptions by imposing potential economic barriers to low-input agriculture adoption. We increased the poultry litter price until activities using poultry litter did not appear in the solution. Then, penalties on the yields, labor requirements, and variable costs of low-pesticide input systems were individually applied at increasing levels, until low-pesticide activities did not appear in the solution. Finally, we examined the impacts of a combination of these penalties.

There are several possible deficiencies of using a model such as ours to analyze potential barriers to the adoption of low-input practices. First, not every potential barrier to low-input found in the literature applies to farm operators in Richmond County. In this basic sensitivity analysis we had several reasons for not assessing the barrier of commodity programs, which many people regard as an important barrier to adoption. Over 45% of the Richmond County farm operators surveyed felt that changes in the program structure would be unlikely to induce them to reduce their pesticide use. (See Giuranna et al. [1991] for more detailed results of this survey.) Furthermore, about 80% of them thought there were significant yield changes under low-input practices, and over 80% felt that higher labor and management requirements would restrict them from adopting low-input agriculture. These barriers appeared to have more impact on the farm operators' decision than commodity programs.

Second, there may be barriers that are highly individualized. The perception of low-input agriculture by farmers is influ-

enced by the type of information they have received and its sources, such as neighbors or government agency representatives. Although maximization of net returns is an important factor in production (Norris, 1988; Hwang, 1990), there are many barriers that are deeply rooted in farmers' perceptions, attitudes, and personal characteristics. These barriers are difficult to model. Our analysis does not address the entire range of possible barriers, depending instead on a simple economic decision-making criterion.

Selected results of the analysis are presented in Table 2, including the production activities, total net returns (in present value), and total labor requirements. These results reveal the changes that occurred when the optimal solution no longer included an organic, low pesticide usage activity or, for the poultry litter scenario, use of organic forms of nitrogen.

Unrestricted scenario

In the unrestricted scenario, the model could select any activity and source of nitrogen in any combination. The model was unrestricted in the broadest sense because it assumed that a single, profit maximizing decision-maker selected production activities for all the tillable land in the county. No differences in production capacity of the land or management were addressed. The unrestricted scenario analysis resulted in the use of organic production activities. Activity 5L (no pesticides, with poultry litter) had lower production costs but the same yields as conventional systems in this scenario. The unrestricted scenario had a total 15-year net return of $41.3 million and total labor requirements of 1,089 million hours.

In reality, Activity 5L is not used for cash grain production in Richmond County, at least as reported in the farm operator survey (Giuranna et al., 1991). Thus, the appearance of this organic activity in the optimal solution suggested that there were factors not considered in the model, including yield changes. We conducted a sensitivity analysis of the unrestricted scenario to evaluate the effects of barriers to low-input agriculture adoption.

Litter price penalty scenario

Currently, poultry litter is not used as a source of nitrogen in Richmond County. However, in other parts of Virginia, the use of poultry litter as a nutrient source is increasing. Richmond County is not close to a source of poultry litter or other organic nitrogen, so that litter would have to be transported long distances. Scheduling problems and additional hauling costs (because poultry litter is so bulky compared to commercial nitrogen) could prevent the establishment of such a market. However, there are plans to develop a vertically integrated poultry operation in an adjacent county.

In the unrestricted scenario, we priced poultry litter at $.066/lb based on the work of Napit (1990). The price included transaction costs, transportation costs, and broker's fees. Total conversion in all 15 years to Activity 3, a low pesticide and low inorganic nutrient activity, occurred at a 30% increase in poultry litter price, that is, to $.086/lb. The solution was fairly sensitive to poultry litter price because the increase, while amounting to only $0.02/lb, nevertheless forced poultry litter activities out of the optimal solution. This price increase could easily be accounted for by a slightly low initial estimate of transportation costs or the brokers' margin. In addition, the farmer may regard a new, less accessible form of nitrogen as costing more than its market price. Thus, we questioned whether at the time of this study, poultry litter was available at a price that allowed for profitable substitution with commercial fertilizer.

Table 2. Summary of selected variable values in the Unrestricted Scenario, the Sensitivity Analysis Scenarios[1], and the Combined Penalty Scenario.

Variables	Scenarios (County Level Results—15-Year Totals)					
	Unrestricted	Litter Price Penalty[2]	Yield Penalty[3]	Labor Penalty[4]	Variable Cost Penalty[5]	Combined Penalty[6]
Production Activities	5L	3	1,14L,12	1,14L,12	1,14L,12	1,3,12
Present Value of Total Net Returns (1988, $ million)	41.3	40.1	30.9	30.9	30.9	31.2
Total Labor (thousand hours)	1,089	901	893	893	893	923

[1] The sensitivity analysis scenario values are from the optimal solution estimated at the critical penalty value. The critical penalty is the penalty at which all organic and low-chemical production activities were excluded from the solution or, for poultry litter, at which the use of poultry litter was excluded from the optimal solution.
[2] The critical penalty for poultry litter was an increase of $.02/lb, or 30%.
[3] The critical penalty for low-chemical and organic activity crop yields was a 40% decrease.
[4] The critical penalty for low-chemical and organic activity labor requirements was a 550% increase.
[5] The critical penalty for low-chemical and organic activity variable costs was a 51% increase.
[6] The Combined Penalty Scenario had a 20% yield penalty on corn and soybeans in activities 3, 3L, 5L, and a 20% penalty on corn and a 25% penalty on soybeans in activities 11L and 16L. There also was a 10% penalty on the labor requirements of low-chemical and organic activities and a 30% penalty on the price of poultry litter.

The basic crop rotation, corn/small grain-double cropped soybeans, did not change in the transition from Activity 5L (no pesticides, with poultry litter) to Activity 3, (low pesticide, no poultry litter). Labor requirements were much lower under the litter price penalty scenario than the unrestricted scenario. Table 2 shows a 15-year total difference of 188 thousand hours between the litter price penalty and unrestricted scenarios. Activity 5L used non-herbicide methods of weed control that required more labor, which explains the higher labor use of the unrestricted scenario. The 15-year discounted total net return was over $1 million lower in the litter price penalty scenario than in the unrestricted scenario. The difference in net returns was due to the addition of pesticide applications when Activity 5L left the solution.

Yield, labor, and variable cost penalty scenarios

The scenarios with yield, labor, and variable cost penalties are similar because when each became large enough to cause a shift to conventional production, it resulted in the same optimal solution. Under these three scenarios, total labor requirements fell by 196 thousand hours and the 15-year total net return decreased by $10.4 million compared with the unrestricted scenario.

One identified barrier to low-input agriculture adoption is farmers' anticipation of lower yields. Current evidence shows that organic, low-pesticide, and low-tillage practices cannot produce the same yields as the more intensive practices (Berardi, 1978; Dabbert and Madden, 1986; Harwood, 1984). However, organic and low-pesticide practices offer savings, such as lower expenditures for nutrients and pesticides. These savings may allow tradeoffs such that low-input agriculture and conventional practices have similar net returns (Taylor, 1989).

We tested the model's sensitivity to organic and low-pesticide yields by reducing the yields until these activities left the optimal solution. We assigned the same yield penalties to corn and soybeans in Activities 3 (low pesticide, low nutrient), 3L (low pesticide, poultry litter), 5L (no pesticides, poultry litter), 11L (no pesticides, poultry litter, cover crop), and 16L (no pesticides, poultry litter, green manure). We assigned no yield penalties to small grains because the Extension weed specialist believed that their yields would not be reduced in these low-input systems (Hagood, personal communication, 1990). (No field data on low-input activity yields in Richmond County were available at the time of this study.) At a 40% yield penalty on corn and soybeans, all low-pesticide and organic activities left the solution. The primary activity was Activity 1 (medium pesticide, medium nutrients), a two-year rotation of corn with double-cropped small grain and soybeans. Activities 14L (no metolachlor, poultry litter, full-season soybeans) and 12 (medium pesticide, medium nutrient, full-season soybeans) appeared irregularly in various years of the analysis. A 40% decline in yields is large; thus, yield penalties alone do not seem to present a substantial barrier to adoption of low-input agriculture.

Two factors, non-herbicide weed control practices and the spreading of poultry litter, heavily influenced the labor requirements of low-pesticide and organic activities. All the organic and low-pesticide activities required several cultivations for weed control. For example, Activity 5L required three cultivations of corn and soybeans. The use of poultry litter (all organic activities and one low-pesticide activity) may require more labor than estimated in the model because of the difficulty in handling such a bulky substance; thus, the labor estimates in these activities may have been low. We increased the labor requirements of organic and low-pesticide Activities 3, 3L, 5L, 11L, and 16L by increments until none of these activities appeared in the solution. At 5.5 times the original labor requirements, the optimal solution was the same as that for the yield penalty scenario. Labor by itself, therefore, does not appear to present a substantial barrier to the adoption of low-input agriculture practices.

The final sensitivity test of organic and low-pesticide production activities increased the variable costs of Activities 3, 3L, 5L, 11L, and 16L until they no longer appeared in the solution. It is possible that the unrestricted scenario underestimates requirements of these activities for inputs such as seed, fuel, and machinery repair. A complete change from low-input agriculture activities came at a 51% increase in variable costs. As with labor and yield penalties, this high variable cost penalty suggests that increased costs alone are not a barrier to low-input agriculture adoption.

Combined penalty scenario

Construction of the combined penalty scenario involved using the critical price of poultry litter determined in the Litter Price Penalty Scenario, $.086/lb, and using recommended yield penalties (Hagood, personal communication, 1990). Activities 3, 3L, and 5L had a 20% yield penalty on corn and soybeans, whereas Activities 11L and 16L had penalties of 20% on corn and 25% on soybeans. The scenario also included a labor requirement penalty of 10% for organic and low-pesticide activities. We did not prevent the use of organic and low-pesticide activities in the model, but penalized their yields, labor requirements, and the cost of organic nitrogen. The scenario did not include a variable cost penalty because a review of the variable cost budgets found them in line with expert opinions, current prices, and farm records.

The optimal solution of the combined penalty scenario selected Activity 1 (medium pesticide, medium nutrient) over most land and years. Activity 12 (medium pesticide, medium nutrient, full-season soybeans) and Activity 3 (low-pesticide, low nutrient) also occurred in the solution. Throughout the model, this combination of penalties resulted in the production activities currently used in Richmond County (Giuranna et al., 1991). Total net returns were $31.2 million, and 923 thousand hours of labor were required over the 15 year period. The combined penalty scenario established a set of parameter values that reflect the possible barriers to low-input agriculture in Richmond County. The optimal solution of the scenario showed that these barriers were restrictive enough to prevent organic activity, but were not severe enough to prevent some use of a low-pesticide activity.

Conclusions

Our simplified objective function in this mathematical model, the maximization of net returns over variable costs, revealed that there are low-input agricultural practices that could be profitable in Richmond County. However, this solution does not

suggest that currently all operators in Richmond County would be earning higher profits using organic methods than they would be with their current practices. Indeed, if such profits were available, one would expect to find more farmers in the county using low-input and organic production practices. Therefore, barriers must exist that prevent such adoption. Whether these are real or only perceived, their effect is the same. In this study, penalties on poultry litter price, yield, labor, or variable costs tested four types of perceived economic barriers.

Farmers in Richmond County currently do not have access to a poultry litter market or a communal county labor supply. That is, the assumption of a pooled labor supply becomes questionable in this Unrestricted Scenario, which had the highest labor requirements of all the scenarios. Furthermore, the actual yields, labor, and other input requirements of low-input agriculture practices are not precisely known. Our study developed a method to overcome yield, labor, and other data limitations and provide a benchmark for comparison when field data become available.

The analysis added economic barriers to adoption of low-input agriculture until the selected scenario more closely represented actual Richmond County farmers' practices. The sensitivity analysis provided insights to the potential economic barriers to adoption of low-input agriculture. The results must be viewed within the context of the model's structure and the way in which barriers were created, not as isolated numerical values.

For example, low-input agricultural practices were generally insensitive to the separate barriers of higher labor requirements, lower yield, and higher variable costs when each was examined individually. However, changes in the price of poultry litter strongly influenced the use of organic activities. This result was significant in that poultry litter was the only source of organic nitrogen, except for small amounts from crop residues and legumes. If a competitive poultry litter market were to develop in Richmond County, the price of poultry litter could decrease. Alternatively, if poultry litter waste becomes an environmental problem in poultry-producing areas, poultry operators may subsidize the disposal of the litter. The price of poultry litter then could decrease, leading to more adoption of low-input practices.

Low-input agriculture systems were uneconomical for farmers only when substantial, and perhaps unrealistic, penalties were individually assigned to labor requirements, variable costs, and yields. The fact that adoption of an organic system was insensitive to labor requirements can partially be attributed to the assumption of a pooled labor supply for the county. However, Extension specialists note that there is a surplus labor supply in Richmond County (Liddington, personal communication, 1989).

There is one important caveat to the conclusion that labor, yields, and variable costs are not significant economic barriers to low-input agriculture adoption. A combination of these barriers may prevent adoption of low-input agriculture. The combined effect of several low economic barriers caused the most profitable activity to change from organic to conventional. Furthermore, the combined penalty scenario presented the most realistic situation in which to evaluate policies to promote low-input agriculture adoption and to test the influence of federal commodity programs.

Our analysis suggests that one must consider the potential barriers to low-input agriculture in a whole farm system setting, and not consider each one separately. It also highlights the importance of not overgeneralizing about either low-input or conventional agriculture. Economically successful farmers of tomorrow will need to practice "high information agriculture" with thorough knowledge of how various factors affect their profits and the environment. The research and extension community, therefore, should anticipate the information needs associated with "high information agriculture" and provide whole farm system analysis that enables farmers to make informed, realistic decisions.

Acknowledgements. This research was supported by a cooperative agreement with the United States Environmental Protection Agency, a grant from the United States Geological Survey, United States Department of Agriculture LISA funds, the Rural Economic Analysis Program of the Department of Agricultural Economics, College of Agriculture and Life Sciences, Virginia Polytechnic Institute and State University, and the Department of Agricultural Economics, Kansas State University.

References

1. Barry, P.J. 1980. Capital asset pricing and farm real estate. Amer. J. Agric. Economics 62(3):549-553.
2. Bartholomew, W.V. 1965. Mineralization and immobilization of nitrogen in the decomposition of plant and animal residues. In W.V. Bartholomew and F.E. Clark (eds). Soil Nitrogen. Agronomy Monograph 10. Amer. Soc. Agronomy, Madison, Wisconsin. pp. 285-302.
3. Berardi, G.M. 1978. Organic and conventional wheat production: Examination of energy and economics. Agro-Ecosystems 4:367-376.
4. Brooke, A., D. Kendrick, and A. Meeraus. 1988. GAMS: A User's Guide. The Scientific Press, Redwood City, California.
5. Buttel, F.H., G.W. Gillespie, Jr., R. Janke, B. Caldwell, and M. Sarrantonio. 1986. Reduced-input agricultural systems: Rationale and prospects. Amer. J. Alternative Agric. 1:58-64.
6. Dabbert, S., and P. Madden. 1986. The transition to organic agriculture: A multi-year simulation model of a Pennsylvania farm. Amer. J. Alternative Agric. 1:99-107.
7. Daberkow, S.G., and K.H. Reichelderfer. 1988. Low-input agriculture: Trends, goals, and prospects for input use. Amer. J. Agric. Economics 70:1159-1166.
8. Diebel, P.L. 1990. An economic analysis of low-input agriculture as a groundwater protection strategy. Ph.D. dissertation. Dept. of Agric. Economics, Virginia Polytechnic Institute and State Univ., Blacksburg.
9. Diebel, P.L., D.B. Taylor, S.S. Batie, and C.D. Heatwole. 1992. Tradeoffs between water quality and the economic impacts of low-input agriculture in the Coastal Plain of Virginia. Staff Paper 92-12. Dept. of Agricultural Economics, Kansas State Univ., Manhattan.
10. Doran, J.W., D.G. Fraser, M.N. Culik, and W.C. Liebhardt. 1987. Influence of alternative and conventional agricultural management on soil microbial processes and nitrogen availability. Amer. J. Alternative Agric. 2(3):99-107.
11. Fleming, M.H. 1987. Agricultural chemicals in ground water: Preventing contamination by removing barriers against low-input farm management.

Amer. J. Alternative Agric. 2(3):124-157.
12. Frye, W.W., and R.L. Blevins. 1989. Economically sustainable crop production with legume cover crops and conservation tillage. J. Soil and Water Conservation 44:57-60.
13. Gilbertson, C.B. 1979. Animal waste utilization on cropland and pastureland: A manual for evaluating agronomic and environmental effects. EPA600-2-79-059. Environmental Protection Technology Series. U.S. Environmental Protection Agency, Washington, D.C.
14. Giuranna, A., B. Dietz, M. Ross, D.B. Taylor, and S.S. Batie. 1991. Characteristics of farming in Richmond County, Virginia. Unpublished paper. Dept. of Agric. Economics, Virginia Polytechnic Institute and State Univ., Blacksburg.
15. Harwood, R.R. 1984. Organic farming research at the Rodale Research Center. In D.F. Bezdicek and J.F. Power (eds). Organic Farming: Current Technology and Its Role in a Sustainable Agriculture. Amer. Soc. Agronomy, Crop Sci. Soc. Amer., and Soil Sci. Soc. Amer., Madison, Wisconsin. pp. 1-17.
16. Hwang, S.W. 1990. Low-input agriculture as a ground water protection strategy in Richmond County, Virginia. Unpublished paper. Department of Agricultural Economics, Virginia Polytechnic Institute and State Univ., Blacksburg.
17. Lockeretz, W., G. Shearer, D.H. Kohl, and R.W. Klepper. 1984. Comparison of organic and conventional farming in the corn belt. In D.F. Bezdicek and J.F. Power (eds). Organic Farming: Current Technology and Its Role in a Sustainable Agriculture. Amer. Soc. Agronomy, Crop Sci. Soc. Amer., and Soil Sci. Soc. Amer., Madison, Wisconsin. pp. 37-48.
18. Madden, P. 1988. Low-input/sustainable agriculture—challenges to the agricultural economics profession. Amer. J. Agric. Economics 70:1167-1172.
19. Murtagh, B.A., and M.M. Saunders. 1987. MINOS 5.1 User's Guide. Report SOL-83-20R. Dept. of Operations Research, Stanford Univ., Stanford, California.
20. Napit, K.B. 1990. The economic potential of establishing a poultry litter handling industry. Ph.D. dissertation. Dept. of Agric. Economics, Virginia Polytechnic Institute and State Univ., Blacksburg.
21. Norris, P.E. 1988. A case study of investment in agricultural sustainability: Adoption and policy issues for nitrogen pollution control in the Chesapeake Bay drainage. Ph.D. dissertation. Dept. of Agric. Economics, Virginia Polytechnic Institute and State Univ., Blacksburg.
22. Perkinson, H.R. 1989. 1989 northern Virginia crop budgets. Virginia Cooperative Extension Service, Blacksburg.
23. Pieters, A.J., and R. McKee. 1938. The use of cover and green-manure crops. In Soils and Men: The Yearbook of Agriculture. U.S. Dept. of Agric., Washington, D.C. pp. 431-444.
24. Power, J.F. 1987a. Legumes: Their potential role in agricultural production. Amer. J. Alternative Agric. 2(2):69-73.
25. Power, J.F. (ed.) 1987b. The Role of Legumes in Conservation Tillage Systems. Soil Conservation Soc. Amer., Ankeny, Iowa.
26. Randall, A. 1987. Resource Economics. John Wiley and Sons, New York, N.Y.
27. Taylor, D.B. 1989. Barriers to the adoption of low-input, sustainable agriculture. Presented at the Third Annual Virginia Conference on Sustainable Agricultural Systems, Charlottesville, March 13-14.
28. U.S. Dept. of Commerce. 1989. 1987 Census of Agriculture. Bureau of the Census, Washington, D.C.
29. Williams, J.L., and G.H. Wicks. 1978. Weed control problems associated with crop residue systems. In W.R. Oschwald (ed). Crop Residue Management Systems. Amer. Soc. Agronomy, Madison, Wisconsin. pp. 165-172.
30. Young, D.L., and W.A. Goldstein. 1988. How government farm programs discourage sustainable cropping systems. In Proceedings of Farming Systems Research Symposium. Fayetteville, Arkansas. pp. 443-459.

Congress Increases SARE Funding

The U.S. House/Senate Budget Conference Committee has approved $7.4 million for the Sustainable Agriculture Research and Education Program (SARE). Earlier this year, the Senate had approved a 1994 SARE budget of $8 million, and the House had approved $6.9 million, the amount proposed by the Administration. The program was funded at $6.7 million in both FY 1992 and FY 1993. The Conferees accepted action taken earlier in both the House and Senate in appropriating $500,000 for implementation of the Organic Food Production Act, which had received no recommended funding in the Administration's proposed budget. The National Organic Standards Board will be funded, but USDA has not yet decided the amount. Funding for the Board and for implementation of the Organic Food Production Act had not been included in either the FY 1992 or FY 1993 final budgets.

An additional $2.963 million was approved by the Conference Committee for SARE programs to be administered by the Extension system. It remains unclear whether this funding would be used for the Sustainable Agriculture Technology Development and Transfer Program (Chapter 3—training of extension agents, or SATDTP), or integrated farming systems (Chapter 2), or some combination thereof. These programs received no funding in FY 1992 or FY 1993.

A group of farm organizations, including the Wallace Institute, had written earlier to Deputy Agriculture Secretary Richard Rominger, requesting that the Administration support the higher SARE budget approved by the Senate, and support conference language to ensure that the Extension Service funding be used for SATDTP, "a prime opportunity to strengthen Extension and to help fulfill the newly-announced commitment to sustainable agriculture," the letter said.

Environment-friendly swine feed formulation to reduce nitrogen and phosphorus excretion

Mark S. Honeyman

Abstract. *The nutrient composition of swine excreta can be altered by manipulating the composition of the pig's diet. Several approaches are reviewed: feeding according to the pig's growth phase, formulation according to the feed's digestible amino acids, use of crystalline amino acids, the ideal protein approach, formulation according to available phosphorus, and the addition of phytase enzymes. Each has the potential to lower nitrogen or phosphorus excretion levels. Together they can dramatically reduce the nitrogen and phosphorus concentration of swine manure, which could be a major advantage in regions with a high density of swine or for swine operations with limited access to arable land. However, the value of the swine manure would be much less as a fertilizer because these two elements are important plant nutrients.*

Key words: swine production, manure, amino acids, digestibility

Introduction

Modern intensive livestock production can have either a very positive or a very negative effect on the environment. In the U.S. Corn Belt, parts of North Carolina, Taiwan, China, the Netherlands, and Denmark, which have dense populations of intensively managed swine, manure can cause serious environmental damage, particularly when it is mismanaged. On the other hand, swine manure is a valuable resource for crop production if handled properly to minimize odor and nutrient loss. Another way to reduce the impact of swine manure on the environment is to manipulate the swine diet to minimize the excretion of certain compounds and maximize the utilization of nutrients, including nitrogen (N) and phosphorus (P).

Journal Paper No. J-15119 of Iowa Agriculture and Home Economics Experiment Station.

Mark S. Honeyman is Assistant Professor of Agricultural Education and Studies and Animal Science, Iowa State University, Ames, IA 50011.

Swine Excreta Composition and Feed Formulation

Excreta are the feces and urine soon after voiding from the animal. Swine waste or manure consists of excreta, waste feed, bedding (depending on housing system), sloughed hair and skin, and waste water. Manure is subject to microbial action immediately after voiding. The rate of microbial action varies with manure composition and environmental conditions. I focus on swine excreta, not manure, which is a highly variable material.

Swine excreta contain indigestible feed components, sloughed cells from the gastrointestinal tract, secretions, intestinal microbes, physiological waste products or waste-product carriers such as uric acid, and unabsorbed metabolites of digestion.

Swine at 61 kg live weight excrete an average of 84 kg of urine and feces per day per 1,000 kg live weight (wet basis, as voided) containing .52 kg N, .18 kg total P and .29 kg K (ASAE Standards, 1990). About 33% of the N is in the feces and 67% in the urine (Smith, 1973).

The composition of excreta depends on four aspects of the diet: the proportions of different feedstuffs and their respective nutrient contents, additives such as enzymes, feed processing, and the amount of feed consumed. The bioavailability of the nutrients, such as minerals and amino acids, also is important. Feeds are processed by a variety of methods to improve their digestibility. However, feed processing is not discussed in this paper.

Several factors influence the pig's nutritional requirements and therefore the composition of excreta: age, sex, weight, and stage of production; health status and intestinal microbial population; genetic composition; and the environment (Pearce, 1979; National Research Council, 1988). As swine production and feed formulation become more sophisticated, feeds could be formulated to attain the twin goals of maximum utilization of feed nutrients and minimum nutrient excretion. Maximum utilization of feed nutrients by the pig is essential to profitable swine production because feed accounts for over 60% of the cost of production (Stevermer, 1992).

Minimizing nutrient excretion would be beneficial to the natural environment, particularly in regions of dense human and swine populations, because lower amounts of nutrients would be released. N and P are of particular interest because the protein supplement and inorganic P supplement that supply these nutrients are, respectively, second and third most expensive components of swine diets, following the energy source (usually a feed grain). Also, N as nitrates or ammonia is highly soluble in water, and nitrogenous compounds are potential pollutants of both surface and groundwater. Phosphates are not highly soluble in water, but adhere to soil parti-

cles. Thus excreted phosphates pose environmental problems primarily through soil movement (erosion). Improved feed formulation to meet the pig's nutrient needs more precisely with highly digestible ingredients holds promise in reducing N and P excretion.

Minimizing N excretion by phase feeding

By matching the feed's nutrient composition to a pig's requirement at a given age and weight, N excretion can be reduced and N retention can be improved. For example, some pigs in Europe are fed a constant diet from 30 to 100 kg live weight. In calculations using distinct grower (30-60 kg) and finisher (60-100 kg) diets, total N excretion was reduced 10-14% (Koch, 1990), as in the example shown in Table 1. This concept can be applied more thoroughly by using a variety of diets to match closely the nutrient requirements of each growth phase. In the U.S., the common practice is to feed a grower diet (20-60 kg) and a finisher diet (60-110 kg). By feeding four diets instead of two during the grow-finish period, N excretion could be reduced even more. Logistics and management set the practical limits on the number of diets.

A proposed strategy is to have two diets, one formulated at each end of the dietary requirement range, which are blended to create the final diet. As the pigs grow and their nutrient requirements change the ratio of the blend changes. This system, once in place, can easily generate an almost limitless series of diets to match the pig's needs.

Exact information on ingredient composition, precise diet formulation, and accurate feed mixing are required for phase-feeding. A survey of commercial swine operations found pigs at the same stage of production receiving widely varying dietary levels of protein and P (Ewan, 1986). These diets may be based on inaccurate information about feed composition and may result in excess nutrient levels in the excreta.

Matching dietary amino acids to the needs of the pig

Formulating swine diets to minimize N excretion is achieved by matching the pig's amino acid needs with dietary amino acids. Several pieces of information are needed: the pig's amino acid needs, the amino acid composition of the feedstuffs, the digestibility and availability of amino acids in the feedstuffs, and the pig's feed intake. Accurate information and precise matching of amino acid needs to dietary supply optimize the efficiency of utilization and minimize excretion of N. Traditionally, diets based on corn and soybean meal have been formulated on a crude protein (CP) basis to meet the pig's need for the first limiting amino acid, lysine. As a result, the remaining amino acids are in excess. This approach does not minimize N excretion, but it is a reasonable practice, given the relative costs of the available feedstuffs.

An alternative is to meet the pig's amino acid needs more precisely by using crystalline amino acids—lysine, tryptophan, methionine, and threonine. These have recently become available, often at a price that is economical for commercial feed formulation. As they become cheaper with large-scale, efficient production plants, their use in swine feeds will become more competitive.

In the Netherlands, Lenis (1989) showed that by reducing the protein content of pig diets by 2% and supplementing with synthetic-crystalline amino acids, N excretion was reduced by 25%. Work in Germany by Franz et al. (1989) demonstrated a 37% reduction in N excretion by barrows and gilts (30-100 kg) when 50% of the soybean meal in a 20% CP diet was replaced by crystalline amino acids and wheat. Feed-to-gain ratio was similar. Koch (1990), using a N excretion model for 55-100 kg pigs, calculated that N excretion was reduced 26% by switching from a 15.5% CP diet supplemented with methionine and lysine to a 13% CP diet supplemented with methionine, lysine, threonine and tryptophan. The model assumed similar daily gain and feed efficiency for the diets, which consisted of corn, barley, soybean meal and canola. The diets met energy and amino acid requirements.

When formulating swine diets on an amino acid basis, it is important to consider the bioavailability of the amino acids provided by the feedstuffs (Sauer and Ozimek, 1986). The most common measure of amino acid bioavailability is ileal digestibility. Ileal digestibility and availabilities from slope-ratio assays are currently the best measures of amino acids available to the pig, and values have been developed

Table 1. Example of two-phase swine feeding.[1]

	Single phase	Two phase		Two phase overall
		Grower	Finisher	
Crude protein, %	16.0	16.5	14.0	14.9
Feed conversion (intake/gain)	3.0	2.5	3.3	3.6
Feed intake/period (kg)	210	75	132	207
N intake (kg)	5.38	1.98	2.95	4.93
N excretion (kg)	3.48	1.16	1.86	3.02

[1] Adapted from Koch, 1990.

for most common feedstuffs (Knabe, 1991). Diets can be formulated more precisely if they are based on digestible rather than total amino acids, particularly for feeds of low protein quality (Fuller and Wang, 1990).

The concept of the ideal protein

The concept of supplying dietary amino acids in a pattern to match the animal's amino acid needs has been developed as the "ideal protein" concept. The first major attempt to specify the ideal protein requirements for pigs was published in *The Nutrient Requirements of Pigs* (Agricultural Research Council, 1981). Since then, considerable work has been done to refine those recommendations (Fuller et al., 1989; Wang and Fuller, 1989; Fuller and Wang, 1990), which are shown in Table 2.

Table 2 also shows the National Research Council (1988) recommended amino acid values, which are lower than the others. One explanation for the difference is that NRC did not propose an ideal protein. Also, the NRC estimates are based on U.S. data for barrows (castrated males) and gilts fed *ad libitum* on high energy feeds, compared with European (ARC) data where boars (intact males) and gilts are fed lower energy diets in a limited feeding regimen. The NRC values represent the accepted standards in the U.S.

Fuller (1989, 1990) characterized an ideal protein in several ways:

- an optimum balance of amino acids in the diet;
- a balance of amino acids in exactly the proportions in which they are required by the pig;
- a pattern of dietary amino acids which gives the highest utilization of the dietary protein;
- a balance of amino acids that cannot be improved by any addition or substitution of amino acids;
- that part of any dietary crude protein which is fully utilizable.

The ideal protein requirements of the growing animal closely resemble and are determined by the amino acid composition of the lean tissue formed.

Effect of ideal protein diets on N balance

N retention can be increased by using diets that match the pig's requirements. For example, Welch et al. (1966) improved N retention by 20% by adding lysine and tryptophan to a corn-soybean meal diet for barrows weighing 50 to 90 kg. Chung and Baker (1991), using a "chemically defined" amino acid diet with 14.77% CP for 10 kg pigs, achieved pig performance and N retention values equal to those of a 20% CP corn-soybean meal-whey diet. In both these studies, N excretion was significantly reduced. In recent work, Chung and Baker (1992) recommended an ideal protein for 10 kg pigs that improved the efficiency of N utilization, as determined by N retention, compared with the amino acid patterns of

Table 2. Recommended balance of amino acids.[1]

			Ideal protein	
	NRC, % of lysine[2]	ARC, % of lysine[3]	Proposed % of lysine[4]	"Improved" % of lysine, 10 kg pig[5]
Lysine	100	100	100	100
Methionine & cystine	51	50	63	60
Threonine	58	60	72	65
Tryptophan	15	14	18	18
Isoleucine	56	54	60	60
Leucine	74	100	110	100
Histidine	26	33	NA	32
Phenylalanine & tyrosine	81	96	120	95
Valine	59	70	75	75
Arginine	NA	NA	NA	42

[1] Amino acid values presented as a percent of lysine level when each amino acid value is calculated as a percent of total protein or grams of amino acid per 16 grams N.
[2] National Research Council, 1988.
[3] Agricultural Research Council, 1981.
[4] Wang and Fuller, 1989.
[5] Chung and Baker, 1992.

National Research Council (1988) or Wang and Fuller (1989) (Table 2).

Reducing P Excretion by Diet Formulation

More than half the naturally occurring P in oilseeds and cereal grains is bound to phytate, an organic compound. Only one-third of the P in phytate is available to swine because pigs lack the digestive enzyme phytase (Peeler, 1972; Cromwell, 1979; Jongbloed, 1987). Cromwell (1989) has shown that only about 10% of the P in corn and 25-35% of the P in soybean meal is used by pigs. The amount and availability of P is variable among feedstuffs; availability ranges up to 50% in wheat (Table 3).

Using available P values in formulating swine diet allows maximum use of the inorganic P and reduces the chances of having too much or too little P. Formulating on available rather than total P offers no particular advantage for corn-soy diets. However, in wheat-soy diets, less supplemental P is needed because the P in wheat is more available. The National Research Council (1988) P requirements are considered minimums; thus Cromwell (1990) recommends about a 20% higher dietary allowance of P in practical swine diets.

Supplementation with microbial phytase from *Aspergillus niger* (1500 units per kg of feed) reduced the total fecal P concentration by 35% on a dry matter basis (Jongbloed et al., 1992). The trial used 37 kg barrows fed a corn-soy diet with no inorganic P supplementation. Overall P digestibility was improved from 13% to 43%.

Supplementation of swine diets with phytase can increase phytate utilization and can decrease P excretion by up to 50% in corn-soy diets when inorganic P supplementation is reduced (Cromwell, 1989, 1991). This innovation, which is not a widespread practice, also is applicable to poultry diets.

Summary

Several approaches to environment-friendly swine-feed formulation could be employed. Phase-feeding pigs according to their stage of production is very useful in matching nutrients to the pig's needs. A "blend-feeding" strategy may be particularly flexible and thus more feasible. Diets can meet the amino acid needs of the pig more accurately when the formulation is based on the digestible amino acid values of the feedstuffs. Also, use of crystalline amino acids may increase as the costs decline. Formulating diets using the "ideal protein" concept, and supplementing with phytase enzyme to increase organic P utilization hold promise in the future.

Implications and Conclusions

With these approaches, swine excreta would contain significantly less N and P. In swine-dense regions with inadequate arable land to recycle the nutrients, this would have an important environmental benefit.

However, the manure would have less value as a source of plant nutrients when applied to cropland. Theoretically, more manure could be applied per unit area, which would reduce application costs. However, other manure components may become a problem, including potassium, heavy metals, and organic matter.

N and P are valuable nutrients for grain production. Therefore, where the manure handling systems minimize losses and the cropping systems minimize soil erosion and runoff, the environmental benefits of reducing the N and P content of swine manure would be much less.

These feeding practices have implications for the future structure of the swine industry. Large confinement units on

Table 3. P and phytate of selected feedstuffs for swine.[1]

	Total P (%)[2]	Phytate (%of total P)[3]	Bioavailability of P (%)[4]	Available P (%)[5]
Corn (maize)	.28	66	12	.03
Wheat	.37	67	50	.18
Soybean meal (44% CP)	.65	61	35	.23
Soybean meal, dehulled (48% CP)	.64	61	25	.16
Meat & bone meal	4.58	NA	68	3.11
Dried whey	.76	NA	76	.58
Fish meal	2.88	NA	102	2.88
Rice bran	1.37	NA	25	.34
Alfalfa meal	.23	0	100	.23
Corn gluten feed	.99	NA	59	.58

[1] Cromwell, 1990.
[2] National Research Council, 1988.
[3] Adapted from Nelson et al., 1968.
[4] Based on research conducted at University of Kentucky, Lexington, cited in Cromwell, 1990.
[5] Total P (column 1) × P bioavailability (column 3).

small land areas would have fewer incentives to return manure to cropland for nutrient recycling. The traditional advantages of linking crop and livestock production through manuring practices would be reduced if the swine manure contained less N and P.

Thus, despite the clear advantages of improved feed utilization efficiency and reduced N and P excretions, we must carefully analyze how these approaches affect the entire agricultural system and the environment. Adoption and appropriateness will depend on many factors, including costs, soils, farming practices, climate, livestock density, and the structure of the industry. As with many new technologies, the apparent advantages are only some of the consequences.

Acknowledgment. This paper was supported by the American Soybean Association, St. Louis, Missouri.

References

1. Agricultural Research Council. 1981. The nutrient requirements of pigs. Commonwealth Agricultural Bureaux, Slough, Great Britain.
2. American Society of Agricultural Engineers Standards. 1990. Manure production and characteristics. D-384. Amer. Soc. Agric. Engineers, St. Joseph, Michigan. pp. 463-465.
3. Chung, T.K., and D.H. Baker. 1991. A chemically defined diet for maximal growth in pigs. J. Nutrition 121:979-984.
4. Chung, T.K., and D.H. Baker. 1992. An improved ideal protein for 10 kg pigs. J. Animal Sci. Midwest Section 1992:71 (Abstract).
5. Cromwell, G.L. 1979. Availability of phosphorus in feedstuffs for swine. In Proc. Distillers Feed Research Conf., Des Moines, Iowa.
6. Cromwell, G.L. 1989. Requirements and biological availability of phosphorus for swine. In Proc. Pitman Moore Nutrition Conf., Des Moines, Iowa.
7. Cromwell, G.L. 1990. Application of phosphorus availability data to practical diet formulation. In Proc. Carolina Swine Nutrition Conf., Raleigh, North Carolina, Nov. 7-8. pp. 55-75.
8. Cromwell, G.L. 1991. Phytase appears to reduce phosphorus in feed, manure. Feedstuffs 63(41):14-16.
9. Ewan, R.C. 1986. Analysis of feeds and feed ingredients—1985. In ISU Swine Research Report 1986. AS-580. Iowa State Univ., Ames. pp. 57-59.
10. Franz, P., D. Dreyer, F.J. Romberg, and A. Salewski. 1989. Adapted crude protein and amino acid supply decreases N-excretion in fattening pigs—a contribution to environment-friendly animal production. Schweinezucht und Schweinemast 37:400-402.
11. Fuller, M.F. 1989. Ideal protein: The concept and its application in swine diets. In Proc. Western Nutrition Conf., Winnipeg, Canada, Sept. 13-14.
12. Fuller, M.F. 1990. Optimum dietary amino acid pattern for maintenance and gain of growing swine. In Proc. Carolina Swine Nutrition Conf., Raleigh, North Carolina, Nov. 7-8.
13. Fuller, M.F., and T.C. Wang. 1990. Digestible ideal protein—a measure of dietary protein value. Pig News and Information 11(3):353-359.
14. Fuller, M.F., R. McWilliam, T.C. Wang, and L.R. Giles. 1989. The optimum dietary amino acid pattern for growing pigs. 2. Requirements for maintenance and for tissue protein accretion. British J. Nutrition 62:255-267.
15. Jongbloed, A.W. 1987. Phosphorus in the feeding of pigs. Institute voor Veevoeding Sonderzoek, Lelystad, Netherlands.
16. Jongbloed, A.W., Z. Mroz, and P.A. Kemme. 1992. The affect of supplementary *Aspergillus niger* phytase in diets for pigs on concentration and apparent digestibility of dry matter, total phosphorus, and phytic acid in different sections of the alimentary tract. J. Animal Sci. 70:1159-1168.
17. Knabe, D.A. 1991. Bioavailability of amino acids in feedstuffs for swine. In E.R. Miller, D.E. Ullrey, and A.J. Lewis (eds). Swine Nutrition. Butterworth-Heinemann, Boston, Massachusetts. pp. 327-340.
18. Koch, F. 1990. Amino acid formulation to improve carcass quality and limit nitrogen load in waste. In Proc. Carolina Swine Nutrition Conf., Raleigh, North Carolina, Nov. 7-8. pp. 76-95.
19. Lenis, N.P. 1989. Lower nitrogen excretion in pig husbandry by feeding: Current and future possibilities. Netherlands J. Agric. Sci. 37:61-70.
20. National Research Council. 1988. Nutrient Requirements of Swine (9th rev. ed.). National Academy Press, Washington, D.C.
21. Nelson, T.S., L.W. Ferrarra, and N.L. Storer. 1968. Phytate phosphorus content of feed ingredients derived from plants. Poultry Sci. 47:1372-1374.
22. Pearce, G.R. 1979. Quality aspects of livestock wastes in relation to their utilization. Agric. Wastes 1:223-226.
23. Peeler, H.T. 1972. Biological availability of nutrients in feeds: Availability of major mineral ions. J. Animal Sci. 35:696-712.
24. Sauer, W., and L. Ozimek. 1986. Digestibility of amino acids in swine: Results and their practical applications. A review. Livestock Production Sci. 15:367-388.
25. Smith, L.W. 1973. Recycling animal wastes as protein sources. In Alternative Sources of Protein for Animal Production. National Academy of Sciences, Washington, D.C. pp. 146-173.
26. Stevermer, E.J. 1992. ISU Swine Enterprise Records Program. In 1992 Swine Research Report. ASL-R970. Iowa State Univ., Ames. pp. 99-104
27. Wang, T.C., and M.F. Fuller. 1989. The optimum dietary amino acid pattern for growing pigs. 1. Experiments by amino acid deletion. British J. Nutrition 62:77-89.
28. Welch, J.G., R.H. Cordts, and G.H. VanderNoot. 1966. Effect of lysine, methionine and tryptophan supplementation upon nitrogen retention of barrows. J. Animal Sci. 25:806-808.

New Irrigation Key to Alternative Cotton System

A Low Energy Precision Application irrigation system is being used on a 160-acre farm where researchers, with help from the SARE Program, are studying sustainable cotton production systems which may result in decreased water and wind erosion, decreased nutrient leaching potential, and pest management with environmentally safe chemicals. For more information, contact William M. Lyle, Project Coordinator, Agricultural Engineer-Irrigation Research, Texas A&M University Research and Extension Center, Rt. 3, Box 219, Lubbock, TX 79401; (806)746-6101.

COMMENTARY

Is sustainable agriculture an elixir for rural communities?

Paul Lasley, Eric Hoiberg, and Gordon Bultena

Abstract. *The transformation of agriculture according to an industrial model has had clear benefits in improving efficiency and lowering production costs, but also has had adverse consequences on rural culture and the environment. Sustainable agriculture offers alternative practices and values intended to promote environmental stewardship, conserve resources, preserve farm traditions, and support rural communities. Strong arguments can be made that it will have these consequences, based on the interactions among agricultural structure, rural community viability, and environmental quality. However, counterarguments can also be made, and the claimed benefits of sustainable agriculture for rural communities must be regarded as not yet demonstrated.*

Key words: structure of agriculture, environmental quality, farm size

Agricultural development in the United States has been guided largely by an industrial model that places emphasis on maximizing productivity and labor efficiency. The major impetus for this model emerged in the mid-19th century because of the widely held belief that agriculture was falling behind industry and commerce (Cochrane, 1979). Proponents of the industrial model argued that rural life could only be improved by increasing agricultural production and efficiency. It was generally believed that agricultural development could be achieved through the adoption of labor-saving machines. To raise production, improve farm income, and provide an adequate standard of living, early proponents of the industrial model prescribed the same scientific, businesslike approach that had been successful in industry. Kirkendall (1991) argues the transition to an industrial agriculture can be viewed as a triumph of the modernizers over the agrarian populists who held to the Jeffersonian vision of small-scale family farm agriculture.

Advances in farm production and efficiency resulting from applying the industrial model of agriculture are well known. The many benefits include an abundant supply of low-cost and nutritious food, farm mechanization, improvements in plant and animal breeding, disease and insect control, and fertility management. But coupled with these widely recognized benefits is a growing recognition of its unintended, adverse consequences for rural culture and the environment (Faeth et al., 1991). Increasingly, people now believe that the era of low cost, abundant food is over, and the cornucopia has been a short-term marvel with long-term costs to society. The heavy reliance on non-renewable fossil energy for fertilizer and fuels, the vulnerabilities of monocultural cropping systems, and widespread environmental contamination and natural resource depletion, coupled with global population pressures, lead many to predict that periods of food scarcity are likely and that food prices inevitably will increase. Other negative social consequences of the industrial model include dwindling numbers of farms and farm families, depopulation of rural communities, chronic agricultural surpluses that have depressed commodity prices, heavy reliance on government subsidies in major export commodities, and chemical contamination of foodstuffs.

Historically, these unintended consequences of the industrial model were seen as externalities, or simply the costs of progress. Recently there has been both broad-based criticism of the industrial model and the promulgation of alternative values and beliefs, with competing visions of agricultural progress. Sustainable agriculture broadens the goals of agriculture beyond efficiency, productivity and profits to include sustainability, community well-being, environmental quality and a desirable agricultural structure.

The farm crisis of the 1980s was a pivotal period in undermining farmers' confidence in the belief in perpetual agricultural progress, a belief fostered by the proponents of industrialized farming. Increasingly, the social costs of pursuing increased farm productivity and efficiency are recognized as jeopardizing the future of family farmers and rural communities. Technological innovation, increased productivity, and higher rates of efficiency are now seen by many as the roots of the malaise that plagues many agriculturally dependent rural communities. We explore whether sustainable agriculture is likely to help undo or reverse some of these problems.

Paul Lasley, Eric Hoiberg, and Gordon Bultena are Professors, Department of Sociology, Iowa State University, Ames, IA 50011. Project Number 3118.

Sustainable Agriculture

Sustainable agriculture is a general concept that reflects an emerging set of agricultural practices and an underlying set of values and beliefs. Alternative agriculture, organic agriculture, regenerative agriculture, eco-agriculture, permaculture, agroecology, and low-input farming, among others, are common labels for alternative models that seek to redefine agriculture. These alternatives espouse goals, such as increased self-sufficiency, sustainability, environmental stewardship, community, and appropriate technology. Alternative agriculture seeks not only to transform farming practices, but also to reassert a system of values about agricultural structure, environmental stewardship, farm life, and community that draws many beliefs from the agrarian populist movement.

These alternative approaches appear to have much in common, including a shared underlying philosophy (Youngberg, 1984; Lockeretz, 1986). Elements in common include: reduced reliance on purchased inputs; substitution of farm produced inputs for synthetic materials such as pesticides and fertilizers; smaller farm size; appropriate technology; reduced consumption of fossil fuels and other nonrenewable resources; greater farm self-sufficiency; and more direct sales to consumers (Youngberg, 1984; Lockeretz, 1986; Beus and Dunlap, 1990). Keeney (1989) defines sustainable agriculture as encompassing "agricultural systems that are environmentally sound, profitable, and productive and that maintain the social fabric of the rural community."

The emergence of sustainable agriculture as an alternative to conventional farming systems has been characterized as a "paradigm shift." Beus and Dunlap (1990), among others, have identified some key elements of the competing agricultural paradigms, including whether they emphasize competition or community. Both conventional and alternative agriculturalists recognize the dramatic changes in the structure of agriculture, but they interpret these changes differently. Competition is viewed as an essential driving force for industrial farming, a force that compels farmers to adopt the latest technology to remain efficient. Conventional agriculturalists believe that agricultural and social progress can be measured by the exodus of people from the agricultural industry (Beus and Dunlap, 1990). A common measure of efficiency in agriculture is the ratio of farmers to consumers. Currently, the USDA prides itself on the fact that only one farmer is needed to feed more than 200 people. According to Beus and Dunlap, conventional agriculturalists believe that society will benefit as the number of farmers declines, since those released will be "freed" for other pursuits and can avoid the "drudgery of farm life." Those who remain can expand and achieve additional efficiencies of scale.

Although both models of agriculture recognize that a decline in farm population harms rural communities, Beus and Dunlap argue that conventional agriculturalists see this as part of the price that must be paid for agricultural progress. On the other hand, alternative agriculturalists vehemently oppose further reductions in the number of farms and the erosion of rural communities. Alternative agriculturalists emphasize cooperation, preservation of farm traditions and rural culture, the importance of small communities, the intrinsic value of farm work, and permanence, quality and beauty in agriculture. Conventional agriculturalists, on the other hand, are motivated by self-interest, and lack interest in farm traditions and rural culture. In this vein, small communities are not viewed as central to agricultural production. Farm work is viewed as drudgery and thus should be replaced by machinery and technology. In the industrial model the emphasis is on speed, quantity, and profit.

Impacts of the Changing Structure of Agriculture on Rural Communities

Sociologists have conducted an impressive array of studies on the relationships between farm structural changes and rural communities (reviewed by Lobao [1990].) This research was largely inspired by the classic study by Goldschmidt (1968) in Arvin and Dinuba, California, in 1946. That study sought to quantify the Jeffersonian ideal "that the institution of small independent farms is indeed the agent which creates the homogeneous community, both socially and economically democratic" (p. 306). These two communities, both located in the San Joaquin Valley, were matched on several factors, including value of agricultural sales, enterprise mix, reliance on irrigation, climate, and distance from urban areas. The major differences between them were in farm scale and organization. Dinuba was surrounded by family farms whereas Arvin was dominated by large, commercialized farms.

Goldschmidt concluded that Dinuba provided a higher quality of life, superior public services and facilities, higher rates of social and political participation, less socioeconomic stratification, less poverty, and a more diverse and stable business sector. The striking differences between these two communities led Goldschmidt to conclude that the structure of agriculture has important impacts on community (McWilliams, 1969; Goldschmidt, 1978). A restudy of Arvin and Dinuba, done as part of the Small Farm Viability Project (1977), reaffirmed the Goldschmidt findings.

Since Goldschmidt's pioneering research, rural sociologists have produced a significant body of knowledge about how the structure of agriculture is related to community viability. This research has focused on the proposition that communities are closely linked to the surrounding agricultural hinterland, so that changes in farm structure bring observable changes in the community. Researchers using diverse methods in different regions of the country have studied the relationships between agriculture structure and rural communities (Heffernan, 1982; Heffernan and Lasley, 1978; Heffernan and Campbell, 1986; Korsching and Gildner, 1986; Lobao, 1990).

Although rural social scientists have employed different methods and analytical frameworks in different settings, "Goldschmidt's general hypotheses remain accepted theoretically and thus continue to shape, if not dominate, research on farm structure and rural communities within the 'new sociology of agriculture'" (Buttel et al., 1990, p. 146). The industrialization of agriculture has been most visible in the declining number of farms and the replacement of family farming by large-scale farming. Both farm size and formal organization of the farm business have been important dimensions of struc-

tural changes in agriculture. Lobao (1990, p. 57), summarizing the impacts of the changing structure of agriculture on rural communities, lists the following as major consequences:

- a decline in or smaller local population;
- lower incomes for some segments of the population, increased income inequality, and increased poverty;
- lower levels of living;
- lowered numbers or quality of community services;
- less democratic participation;
- lower community social participation and integration;
- decreased retail trade, and fewer retail outlets;
- environmental pollution, depletion of energy sources;
- greater unemployment; and
- rigid class structure.

In assessing agriculture-community linkages, Heffernan (1982, pp. 340-341) concludes that:

> all relevant research to date suggests that a corporate type of agriculture results in a reduction in the quality of life for at least some people, especially the hired worker in rural communities. No single study or set of studies can answer all of the research questions, but it seems significant that a dozen studies, spanning four decades and all regions of the nation, and performed by different researchers using different methodologies, have rather consistently shown that a change toward corporate agriculture produces social consequences that reduce the quality of life in rural communities.

The Relationships between Farming Systems and Community Viability

Given the established symbiotic relationships between the structure of agriculture and the quality of rural life, what implications does the adoption of a more sustainable agriculture hold for rural communities? Past studies of the social consequences of structural changes in agriculture have illuminated the effects of the industrial model on rural communities. The harmful community effects of the changing structure of agriculture represent unintended consequences of pursuing the industrial model. The replacement of family farms by large-scale, industrial farms using hired labor can be posited as having important social consequences for the quality of life in rural communities (Figure 1).

As shown in Figure 1, critics of industrial farming point to the negative impacts on both environmental quality and family farms, which in turn undermine the viability of rural communities. Industrial agriculture is alleged to have adverse impacts on environmental quality (A). Depletion of natural resources and heavy reliance on fossil fuels and pesticides are frequently cited as environmental costs that stem from the industrial model. The decline in the number of family farmers is viewed as a consequence of the industrial model, a direct result of substituting technology for labor (C). The demise of family farms and the accompanying decline in farm population is seen as bringing diminished retail sales, business failures, and outmigration, all of which jeopardize community viability (D). Environmental damage from exploitive agricultural practices, including contaminated drinking water, degraded recreational areas, and perceived unhealthy environments also are seen as having negative effects on rural community viability (B).

What are the Likely Community Impacts of Sustainable Agriculture?

In contrast to the impacts of the industrial model, the conceptual links between sustainable farming and rural community viability are shown in Figure 2. The rationale behind the model in Figure 2 is that adoption of sustainable farming techniques will produce positive outcomes for the environment, for strengthening family farms, and for rural communities. Turning first to the relationship between sustainable farming and the environment (A), it is argued that a positive association exists between sustainable agriculture and environmental quality. The substitution of environmentally benign practices for chemicals and synthetic fertilizers is expected to enhance the environment. Increased reliance on locally produced inputs is expected to reduce production costs and result in less use of fossil fuels. A cleaner, more wholesome and healthy environment is expected to promote rural community living (B). Em-

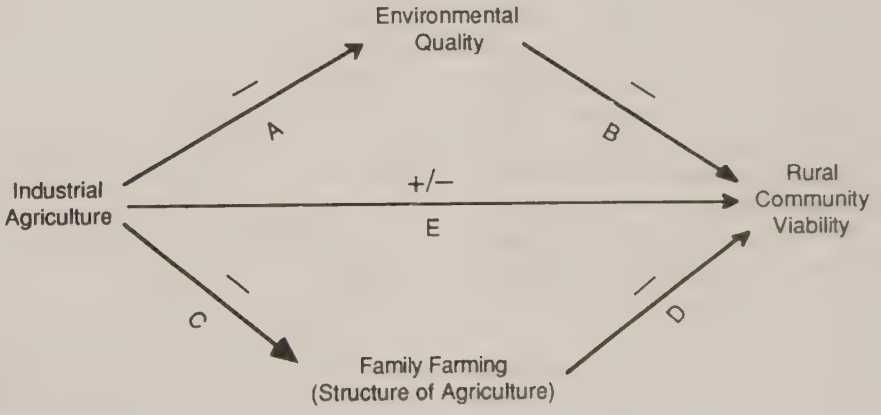


Figure 1. Posited adverse impacts of the industrial model of agriculture.

pirical studies of people's preferences for small towns and open country living often find that a cleaner, more healthful environment is an important consideration (Zuiches, 1981). To the extent that the rural environment benefits from sustainable agriculture, rural communities should be viewed as better places to live.

Advocates of sustainable farming argue that it is more amenable to family farm structures and that an increased number of viable family farms will contribute to increased community viability. Drawing from Schumacher's (1973) discussion about the limits of size, Berry (1987, p. 359) argues that there is a natural ratio between eyes and acres. According to this perspective, farming should not be viewed as an industrial process, but instead as a system requiring great care and attention. Thus, sustainable farming is more likely to be practiced on family farms than on large-scale industrial farms, leading to the expectation that sustainable farming will be positively associated with family farms (C). The basis for the expected positive relationship between family farming and community viability (D) is the Goldschmidt hypothesis discussed earlier. Together, an enhanced environment and more family farmers constitute the indirect effects of sustainable farming on communities. Direct effects also are expected (E), but we do not have clear evidence of their nature.

A key question is whether sustainable agriculture will result in healthier, more resilient rural communities. The historical evidence is unclear. During the post-war boom of the 1940s and again in the 1970s, when farmers enjoyed relative prosperity, millions of farmers used this opportunity to leave agriculture. When commodity prices were high and the price of land and machinery soared, it was a good time to sell out, especially where there were non-farm employment opportunities. Those leaving farming often did not move to the local community, but instead left the region, creating a massive rural to urban migration stream.

The off-farm migration triggered by economic hardship during the decade of the farm crisis took a heavy toll on rural communities. But whether a prosperous agriculture will result in prosperous rural communities is still untested. During the 1970s, when the farm economy enjoyed prosperity, many rural communities did not fare well. Perhaps even in agriculturally dependent rural communities, a prosperous farm sector is a necessary but not sufficient condition for community viability. In many rural communities, the economic well-being of agriculture may have little direct bearing on the overall economic well-being of the community.

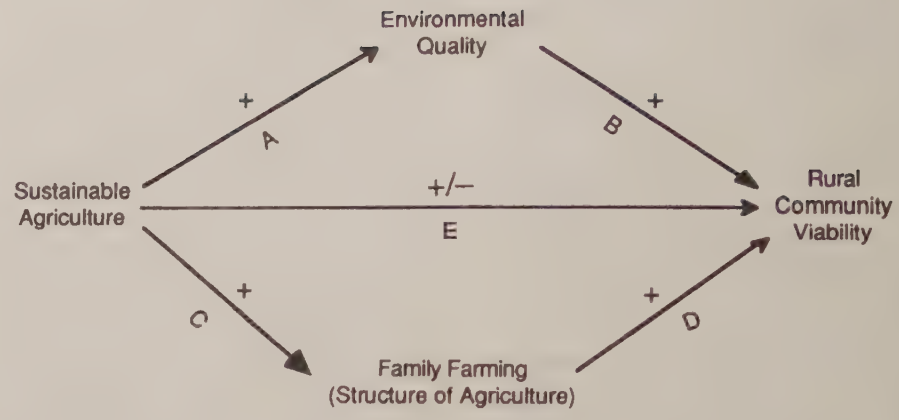


Figure 2. Posited beneficial impacts of sustainable agriculture.

Many federal farm programs are based on an unproven idea that a prosperous agriculture will rejuvenate rural America. Much of the response to the farm crisis was based on the belief that if the farm economy was strengthened, rural communities would benefit. Attention to the farm economy may have resulted in less attention being directed to broader community development issues. The failure to integrate agricultural development with rural development has contributed to viewing these activities as competitive rather than complementary.

A key assumption made by proponents of sustainable agriculture is that it will result in smaller farm size, increased numbers of farms, and increased demand for labor, and thus more people on the land to support rural communities. This untested assumption flows from observations that by replacing labor with technology, industrialized farming has been responsible for fewer and larger farms and declines in the farm population. It is uncertain whether a change to sustainable farming will be able to reverse these structural trends.

A more sustainable agriculture may enhance environmental quality, but is it realistic to expect it to rejuvenate rural America and to reverse the long period of decline? Because of the emphasis on practices specific to the farm or field and increased levels of husbandry, sustainable farming is viewed as more compatible with family farming than industrial farming. Proponents argue that sustainable farming will be more labor and management intensive and therefore will create more jobs (Strange, 1991). An increased number of family farms is seen as reducing stratification among producers and fostering rural community viability. Strange (1991) suggests that sustainable farming is a rational strategy for producers since it will use underutilized farm resources more completely, reduce costs of production, diversify agriculture, and conserve non-renewable resources. He further argues that having more family farmers with higher incomes will lead to increases in retail sales, diversification of agribusiness outlets and services, and use of recycled products. Flora (1990) predicts that sustainable

farming will result in new employment and entrepreneurial opportunities because farmers will need new products and services.

Arguments for positive community impacts of sustainable farming systems are countered by critics who contend that these systems may be harmful to the general welfare of rural communities. The counterarguments are based on the assumption that a significant reduction in purchased inputs could harm community-based agribusiness and that the increased labor demands of sustainable farming will leave less time for involvement in family and community activities. Furthermore, insofar as sustainable farmers depend on specialized niche markets, they may have to bypass local processors to find buyers for their products. Although a significant shift toward sustainable agriculture could substantially reduce farmers' dependence on traditional purchased inputs, its ultimate effects on rural communities remain unclear.

To make a more convincing argument that the increased use of sustainable farming will prove beneficial to rural communities, it is necessary to explore the producers' reasons for adopting sustainable farming practices. Often these motivations stress individual or private benefits, such as reduced outlays for purchased inputs and protection of family health. Yet the rationale for sustainable farming often addresses social or public benefits, such as fostering family farms, improving the environment, and strengthening the local community. From the perspective of Olson (1965), there is confusion over the distinction between individual and public benefits. Although producers may adopt sustainable farming techniques to improve their personal situations, it is not clear whether adoption would occur if only public benefits resulted. A cleaner and more healthful environment, a more vibrant rural community, more local jobs, and less dependence on foreign energy sources clearly are public benefits, but by themselves may be insufficient to persuade farmers to adopt sustainable practices. As with other programs where the major benefits are public or social, such as soil conservation, public assistance may be required to encourage a movement toward sustainable farming.

Propositions that Need to be Explored

Adoption of sustainable farming requires both the implementation of alternative agricultural practices and acceptance of a new philosophy. Simply adopting the practices without accepting the philosophy of this alternative vision would probably result only in modest, short-term changes. Farmers' acceptance of the values included in the sustainable farming philosophy, such as cooperation, preservation of farm traditions and rural culture, fostering family farms, farming as a way of life, permanence, beauty and quality, may ultimately be more important to the viability of family farming and rural communities than the adoption of specific practices. Survey research among Iowa farmers has recently found that larger farmers are most likely to hold negative attitudes about sustainable agriculture, although the use of sustainable farming practices has not been consistently linked to farm size (Bultena et al., 1993; Lasley et al., 1990). To present a convincing argument that sustainable agriculture will strengthen rural communities, it will be necessary to prove that sustainable farmers are stronger proponents of a public good or community philosophy. Will practitioners of sustainable farming be more civic or community minded? Will they participate more in community affairs? Will they be more likely to cooperate in community problem solving? Although Dahl et al. (1991) found little convincing evidence that sustainable farmers were more involved in community activities than conventional farmers in North Dakota, there is some speculation that the sustainable agricultural philosophy may be changing community residents' views toward regional self-sufficiency. If parallel philosophies leading toward a new rural ethos are developing among farmers and among rural community residents, there could likely be a synergistic and symbiotic effect.

Another proposition that needs to be tested is whether the adoption of sustainable agriculture will contribute to more local employment opportunities, or simply bring a shift in employment patterns. Many rural communities need additional jobs to retain their population base. Substituting one class of jobs for another may produce few net benefits for a community. Not only the number but also the quality of the jobs created will be important in making a persuasive case for sustainable farming. Creating jobs with adequate incomes and benefits will be important for the long-term acceptance of sustainable agriculture.

Some critics of sustainable agriculture argue that the wholesale adoption of sustainable farming will result in agribusiness layoffs as farmers reduce their purchases of seeds, pesticides, and fertilizers. Proponents argue that any jobs lost in agribusiness will be replaced by new jobs for services and products such as crop scouting, soil testing, and marketing organic inputs. Also, proponents argue that revenues from the sales of commercial seeds, fertilizers, and pesticides have a small economic multiplier effect on the community, and that the profits are quickly siphoned off to distant urban centers. They maintain that greater use of locally produced inputs will have a larger economic multiplier effect on rural communities.

Berry (1987, p. 356) observed that farmers got into trouble when they decided it was better to own their neighbor's farm than to have a neighbor. The philosophy of sustainable farming entails the opposite value. However, there is little evidence to support or refute the proposition that sustainable farmers are necessarily better neighbors than conventional farmers. This discussion reflects the research inspired by the Goldschmidt hypothesis and the widely held belief that family farmers are more likely to be involved in community affairs. Additional research should compare how different farmers who use different systems participate in community activities.

Farm size may prove to be a more important predictor of community participation and organizational involvement than farm type. If sustainable farms indeed are smaller because of the intensive nature of the practices and their labor/managerial requirements, the result should be more farms and farm residents, and communities seemingly will benefit. However, there is little theoretical or empirical evidence to suggest that farmers practicing one type of farming system are more community minded than another. Future research should explore whether farm size or farm type predicts community participation bet-

ter. In this regard, acceptance of the sustainable farming philosophy, which encompasses the types of social relationships to be fostered by small farm agriculture, should be a better predictor of community involvement than the types of implements or inputs used.

An improved understanding of the importance of alternative patterns of social organization among farmers is needed to assess levels of participation and attachment to community. Sometimes farmers may be more active because there are more opportunities to participate in local community affairs. In other cases, there may not be enough farmers for them to have an effective role in community decision-making or to support each other in using sustainable practices. Without enough like-minded producers, there will be inadequate opportunities for networking. Innovators using sustainable farming practices may be forced to seek interactions with farmers outside the community because of the lack of local opportunities. A supportive community could foster producer organizations where interested farmers and local residents could explore the potential of sustainable agriculture. Previous research has shown the important role of social organization in the adoption and diffusion of agricultural innovations (Rogers, 1983). Producer groups, marketing associations, cooperatives, and other types of voluntary associations may prove instrumental in the adoption of sustainable practices.

Previous research has explored the purchasing patterns of operators of differing farm size (Korsching, 1984). Future research should explore whether sustainable farmers are more likely to buy inputs and sell products locally. Sustainable farmers probably will have to travel greater distances to buy specialized inputs and to find adequate markets. Previous research suggests that innovators in sustainable agriculture are likely to seek information from beyond the local community. The introduction of new information and technologies from more distant sources is a major distinguishing trait of innovators. Knowing where sustainable farming innovators will seek information and inputs and how far they will travel to market their products may yield a better understanding of the community impacts of sustainable farming.

Finally, sustainable agriculture must be seen as much broader than sustainable farming. For sustainable agriculture to make much difference in the fortune of rural communities, food processing and marketing must be decentralized. Currently, only 24 cents of the consumer food dollar goes to producers, with the remaining 76 cents going for processing and marketing (Dunham, 1991). Capturing some processing and marketing jobs will be important for communities if they are to benefit from sustainable agriculture.

A major weakness in the sustainable farming argument is how processing and marketing jobs will be captured for local community development. Future analyses should explore how decentralization of the food processing and marketing sectors can be achieved to create jobs in local communities.

There is little question that a new philosophy about agriculture is beginning to emerge. Still to be documented are the farm operator's long-term commitment to this alternative vision, and whether this commitment will ultimately make any difference to the viability of rural communities.

References

1. Berry, W. 1987. A defense of the family farm. In G. Comstock (ed). Is There a Moral Obligation to Save the Family Farm? Iowa State Univ. Press, Ames. pp. 347-360.
2. Beus, C.E., and R.E. Dunlap. 1990. Conventional versus alternative agriculture: The paradigmatic roots of the debate. Rural Sociology 55(4):590-616.
3. Bultena, G., E. Hoiberg, S. Jarnigan, and R. Exner. 1993. Transition to a more sustainable agriculture in Iowa. Dept. of Sociology, Iowa State Univ., Ames.
4. Buttel, F., O.F. Larson, and G.W. Gillespie, Jr. 1990. The Sociology of Agriculture. Greenwood Press, New York, N.Y.
5. Cochrane, W.W. 1979. The Development of American Agriculture: A Historical Analysis. Univ. of Minnesota Press, Minneapolis.
6. Dahl, B., G. Goreham, R. Jacobsen, R. Sell, L. Stearns, D. Watt, and G. Youngs. 1991. Impacts of sustainable agriculture on North Dakota communities. Agric. Economics Rept. No. 272. Dept. of Agric. Economics, North Dakota State Univ., Fargo.
7. Dunham, D. 1991. Food spending and prices rise, but Americans' share of income spent on food declines. Farmline (July):17.
8. Faeth, P., R. Repetto, K. Kroll, Q. Dai, and G. Helmers. 1991. Paying the farm bill: U.S. agricultural policy and the transition to sustainable agriculture. World Resources Institute, Washington, D.C.
9. Flora, C.B. 1990. Sustainability of agriculture and rural communities. In C.A. Francis, C.B. Flora, and L.D. King (eds). Sustainable Agriculture in Temperate Zones. John Wiley and Sons, New York, N.Y. pp. 343-359.
10. Goldschmidt, W. 1968. Small business and the community: A study in the central valley of California on effects of scale of farm operations. In Corporation Farming. Hearings before the Subcommittee on Monopoly of the Select Committee on Small Business, U.S. Senate. pp. 303-433
11. Goldschmidt, W. 1978. As You Sow: Three Studies in the Social Consequences of Agribusiness. Allanheld, Osmun and Co., Montclair, New Jersey.
12. Heffernan, W.D. 1982. Structure of agriculture and quality of life in rural communities. In D.A. Dillman and D.J. Hobbs (eds). Rural Society in the U.S.: Issues for the 1980s. Westview Press, Boulder, Colorado. pp. 337-346.
13. Heffernan, W., and R. Campbell. 1986. Agriculture and the community: The sociological perspective. In P. Korsching and J. Gildner (eds). Interdependencies of Agriculture and Rural Communities in the Twenty-First Century: The North Central Region. North Central Regional Center for Rural Development, Ames, Iowa. pp. 41-54.
14. Heffernan, W.D., and P. Lasley. 1978. Agriculture structure and interaction in the local community: A case study. Rural Sociology 43:348-361.
15. Keeney, D. 1989. Toward a sustainable agriculture: Need for clarification of concepts and terminology. Amer. J. Alternative Agric. 4:101-105.

16. Kirkendall, R.S. 1991. A history of American agriculture from Jefferson to revolution to crisis. In G.L. Johnson and J.T. Bonnen, with D. Fienup, C.L. Quance, and N. Schaller (eds). Social Science Agricultural Agendas and Strategies. Michigan State Univ. Press, E. Lansing. pp. I:14-23.
17. Korsching, P.F. 1984. Farm structural characteristics and proximity of purchase location of goods and services. In Research in Rural Sociology and Development. Vol. 1. JAI Press, Greenwich, Connecticut. pp 261-287.
18. Korsching, P., and J. Gildner (eds.). 1986. Interdependencies of Agriculture and Rural Communities in the Twenty-First Century: The North Central Region. North Central Regional Center for Rural Development, Ames, Iowa.
19. Lasley, P., M. Duffy, K. Kettner, and C. Chase. 1990. Factors affecting farmers' use of practices to reduce commercial fertilizers and pesticides. J. Soil and Water Conservation 45(1):132-136.
20. Lobao, L.M. 1990. Locality and Inequality: Farm and Industry Structure and Socioeconomic Conditions. State Univ. of New York Press, Albany.
21. Lockeretz, W. 1986. Alternative agriculture. In K.A. Dahlberg (ed). New Directions for Agriculture and Agricultural Research. Rowman and Allanheld, Totowa, N.J. pp. 291-311.
22. McWilliams, C. 1969. Factories in the Fields: The Story of Migratory Farm Labor in California. Archon Books, Hamden, Connecticut.
23. Olson, M. 1965. The Logic of Collective Action. Harvard Univ. Press, Cambridge, Massachusetts.
24. Rogers, E.M. 1983. Diffusion of Innovations. 3rd ed. The Free Press, New York, N.Y.
25. Schumacher, E.F. 1973. Small is Beautiful: Economics as if People Mattered. Perennial Library, New York, N.Y.
26. Small Farm Viability Report. 1977. The family farm in California: Report on the small farm viability project. Employment Development, Governor's Office of Planning and Research, Dept. of Food and Agriculture, and Dept. of Housing and Community Development, Sacramento, California.
27. Strange, M. 1991. Rural Economic Development and Sustainable Agriculture. Center for Rural Affairs, Walthill, Nebraska.
28. Youngberg, G. 1984. Alternative agriculture in the United States: Ideology, politics and prospects. In D. Knorr and T.R. Watkins (eds). Alterations in Food Production. Van Nostrand Reinhold, New York, N.Y. pp. 107-135.
29. Zuiches, J. 1981. Residential preference in the United States. In A. Hawley and S.M. Mazie (eds). Nonmetropolitan America in Transition. Univ. of North Carolina Press, Chapel Hill, pp. 72-115.

Clinton Administration Confirms Plans to Reduce Pesticide Use

The U.S. Department of Agriculture, the Environmental Protection Agency, and the Food and Drug Administration have reaffirmed their commitment made in June to reduce the use of pesticides and promote sustainable agriculture. In a recent briefing before joint House and Senate committees dealing with pesticides, the three agencies agreed to speak with one voice in an attempt to come to grips with the inconsistencies in the nation's pesticide laws that have frustrated farmers, consumers, environmentalists, scientists, administrators, and lawmakers for more than a decade.

The three agencies proposed a host of statutory changes and new initiatives intended to strengthen existing pesticide laws, to upgrade the scientific basis for pesticide regulation, and to prevent pollution and minimize risk through appropriate reduction in pesticide use.

The major statutory changes recommended are as follows: (1) repeal the Delaney Clause, which bans the use of carcinogenic pesticides in processed foods, and replace it with a health-based negligible risk standard for all foods; (2) phase out the present risk-benefit approach which balances economic benefits in determining tolerance levels in raw foods; (3) bring all pesticides under tolerance review within seven years and require reregistration every 15 years; (4) allow for fast-track review to remove dangerous pesticides within three to four years; (5) give the FDA authority to recall and embargo foods and to levy civil penalties for non-compliance; (6) authorize EPA to phase down and phase out pesticides of concern with less litigation than at present; (7) strengthen EPA's authority to mandate prompt pesticide label changes; (8) make it possible to include integrated pest management (IPM) as a mandated part of pesticide applicator certification and training programs; (9) allow more flexibility to authorize certain pesticides for prescription use; and (10) restrict U.S. manufacture and distribution to other countries of pesticides banned or not registered in this country because of health and safety reasons (the "circle of poison" provision).

Proposals to upgrade the scientific basis for pesticide regulation lean heavily on the recent National Research Council's report, *Pesticides in the Diets of Infants and Children.* The Administration proposes to put greater emphasis on food consumption patterns of children and multiple exposure data, including exposure from pesticides used in the home, on lawns, and in drinking water. It also recognizes the need for more consideration of cumulative effects of pesticides with similar active ingredients, and calls for more information on the unique aspects of infants and children in order to set appropriate negligible risk tolerance levels.

The third leg of the Administration's initiative calls for increased efforts in prevention of risk exposure. Its proposals state clearly that Americans need to reduce their use of pesticides. The Administration first recommends regional ecosystem-based pilot projects to reduce pesticide risks, and proposes to have IPM programs in place on 75 percent of the nation's farmland acreage by the year 2000. In addition, the Clinton Administration supports market-based incentives to reduce risks, such as labeling foods to encourage consumers to purchase food grown with few or no pesticides.

The three federal agencies have agreed to put their proposals in bill form, thereby presenting a third alternative to the Kennedy-Waxman bill (S.331, H.R. 872) and the Lehman-Bliley bill (H.R. 1627).

Building Soils for Better Crops: Organic Matter Management. 1993. By Fred Magdoff. University of Nebraska Press, PO Box 880520, Lincoln, NE 68588-0520. xii+176 pp. $22.95 hardcover.

Agriculturalists through the years have been well educated about the benefits of soil organic matter for natural soil properties that are important for productivity and environmental functions. Few if any of these effects are negative; most enhance crop production and environmental quality, often at little cost to the producer. Yet ironically, modern conventional agriculture has taken a course that has tended not to maximize the benefits of organic matter, and instead chosen a management strategy that relies heavily on increasing artificial inputs. Fred Magdoff points out that these systems are likely not to be sustainable because of several adverse side effects, particularly to the environment. His book makes the case for organic matter management as a better approach for farming that will help achieve a greater degree of sustainability. Scientifically this makes good sense as a way toward helping solve many problems related to today's agriculture.

In the preface, Magdoff explains that although much has been written about soil organic matter there is a void in the literature on organic matter management. The strengths of this book are its scientific basis, its relevance to modern day agriculture, and its elementary presentation style, which can be understood by most practitioners who work with the soil.

Part 1 consists of four chapters that describe the make-up or components of organic matter, including the living portion, the nonliving but largely undecomposed materials, and the well-decomposed part of soil organic matter commonly called humus. Chapter 2 makes clear the diversity of organisms in a healthy living soil and the tight interaction that exists among the different types and species. The key in management is to produce the proper conditions by returning adequate amounts of organic materials to enable the various soil animals and flora to restore and maintain the soil's fertility and improve its physical properties. People often forget or do not fully realize the many roles played by soil organic matter that are crucial to a well functioning agriculture and environment. These include enhancing soil tilth, detoxifying wastes, regulating carbon and water cycles, and serving as a reservoir for various plant nutrients and as a buffer against pH change. The book also emphasizes the connection between healthy plants and a healthy soil made possible by a good supply of organic matter.

Part 2, with seven chapters, gets to the heart of soil organic matter management and regulation. Several possible management strategies are discussed, including controlling soil erosion, growing sod crops in the rotation, and regularly applying organic materials to the soil, such as manures, composts, and crop residues. There is a good discussion of the appropriate use of animal manures, composts, cover crops, and crop rotations in fertility management. All have their merits, and as Magdoff points out, must be considered from the standpoint of site specific applications. Reduced tillage, discussed in Chapter 9, is highly effective for soil organic management because it not only promotes residue retention and slows organic matter decomposition, but also controls soil erosion. In "putting it all together" (Chapter 12) the author places the decisions on integrating practices for building and maintaining organic matter back into the hands of the land-user because of the great range of conditions that exist in the real world.

The last two chapters discuss organic matter dynamics and chemical properties. Mathematical approaches that are useful for approximating organic matter dynamics range from a simplified equilibrium model to a first order rate model that includes an equilibrium term. These models can be used to evaluate how practices change the organic matter content before equilibrium has been reached and at equilibrium. Some very useful information is also presented on the limitations of using organic matter content and nitrogen content to indicate nitrogen availability to plants.

The chapter on chemistry of organic matter relates the characteristics of humic materials to their chemical composition and explains the variable charge and pH buffering capacity of soil organic matter. The influence of soil organic matter on cation exchange capacity and the effect of liming on pH are especially important in managing the fertility of some soils.

This book does not present in-depth information on organic matter concepts and management practices. That was not its intended purpose. It does a remarkably good job of presenting some fairly complex concepts about soil organic matter in a language that can be understood by gardeners, farmers, and others who work with agricultural soils, and it provides information that is of immediate practical use. The book title very appropriately reflects its contents.

Robert I. Papendick, Soil Scientist, USDA Agricultural Research Service, Pullman, WA 99164.

American Dreams, Rural Realities: Family Farms in Crisis. 1993. By Peggy F. Barlett. University of North Carolina Press, PO Box 2288, Chapel Hill, NC 27515-2288. xxii+305 pp. $45 hardcover; $18.95 paper.

What was the impact of the farm crisis and what were the characteristics of the farm families that survived it? In answering these questions through a 1982-1992 longitudinal study of farm families in Dodge County, Georgia, anthropologist Peggy Barlett reveals a great deal about the economic and cultural forces influencing American agriculture. She also explodes what is left of the myths about effective strategies for farming for the future.

Most of the research exploring the interaction of culture, community, and the structure of agriculture has been done in the Midwest. There, an egalitarian frontier

tradition and the permanence of strong, ethnically based communities have created contrasting "yeoman" and "entrepreneurial" strategies (Flora and Stitz, 1985; Salamon, 1992). The plantation South lacks yeoman communities. In the non-plantation South, including Dodge County, King Timber created a class of itinerant workers in the lumber industry and King Cotton created a legacy of tenant farming. The resulting high levels of inequality meant there was no community based on a shared agrarian ideology that honored work, independent production, and family farming.

Nevertheless, Barlett found that some farm families shared an agrarian ideology, in contrast to an industrial ideology that focuses on consumption, status, and individualism. Their agrarian ideology was associated with other family attributes and activities that allowed them to survive the farm crisis. However, rather than stemming from the community, this ideology was an individual attribute related to one's family and peers. It could vary within families and among friends, causing lack of cohesiveness within farming communities.

The agrarian moral economy was associated with a cautious management style, which included resisting expansion and rejecting subsidized drought credit from federal agencies. Turning down easy credit in the 1980s was among the most important actions that helped insure financial viability in the 1990s. In contrast, farmers with an ambitious management style who sought such credit to expand and to increase consumption either were out of business or had low financial viability in the 1990s.

However, even farmers with an agrarian moral economy were unaware of the environmental impacts of their farming decisions. Decreasing soil fertility, water contamination, and high rates of soil loss all were viewed as inevitable, and therefore not areas for human concern. Those with a cautious management style decreased their use of pesticides to save money, not for environmental reasons. A moral economy that favors savings over consumption does not guarantee a more sustainable agriculture. Therefore environmentalists, farm organizers, extension agents and others who work with cautious managers must link environmental concerns to other agrarian values, such as family and independence.

In a setting where farm families were looked down upon as uneducated and low class, there were strong pressures to consume to show one's social worth. To regard consumption level as the source of family status is characteristic of an industrial model of marriage, in which the husband has the primary responsibility as breadwinner and the wife the primary responsibility as homemaker. In this model, the wife's personal aspirations emphasize family consumption, caretaking, and the children's achievements. The wife has little emotional attachment to farming except from a desire to support her husband. The goal is for the wife not to work, either on farm or off. When she does work, her earnings are her discretionary fund, in keeping with her husband's having primary financial responsibility.

In contrast, in the agrarian model the husband and wife are partners in the farm enterprise, sharing financial responsibilities. The wife's personal aspirations are linked to the success of the farm, and she has an emotional attachment to the farm and farm life. When the wife has a job, the income is pooled, reflecting joint responsibility. The analysis of these two contrasting marital models, and the different ways they determine men's and women's differential access to land, labor, and capital, is perhaps the greatest contribution of this excellent and readable book.

This book makes an important contribution to our understanding of the cultural dynamics of the farm economy. Barlett shows that culture interacts with federal policies and economic trends to determine the future structure of agriculture. The evidence from Dodge County makes clear that bigger is not better, nor more likely to survive.

Cornelia Butler Flora, Professor, Department of Sociology, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061.

References

1. Flora, J.L., and J.M. Stitz. 1985. Ethnicity, persistence, and capitalization of agriculture in the Great Plains during the settlement period: Wheat production and risk avoidance. Rural Sociology 50(3):341-360.
2. Salamon, S. 1992. Prairie Patrimony: Family, Farming, and Community in the Midwest. Univ. of North Carolina Press, Chapel Hill.

Ancient Futures: Learning from Ladakh. 1992. By Helena Norberg-Hodge. Sierra Club Books, 730 Polk St., San Francisco, CA 94104. 204 pp. $25 hardcover.

Unfamiliar to most people in the West, Ladakh is an intriguing desert enclave high in the Himalayas between Pakistan, China, and Tibet. Now part of the Indian state of Jammu and Kashmir, Ladakh was inhabited for more than a thousand years by people living in semi-isolation but in harmony with the climate and natural resource base. *Ancient Futures* describes this traditional culture, with its bioregional food system based on barley, wheat, peas, turnips, several indigenous food and forage plants, and hardy animals that can withstand the rigors of grazing at 10,000 to 18,000 feet above sea level. Most of the population's building materials, fuel, clothing, food, and other needs traditionally come from their crops, animals and the natural environment. The culture is based on both Buddhist and Moslem traditions, and the society and local economy have been remarkably sustainable for centuries.

Norberg-Hodge is a Swedish linguist who has spent half of each of the past sixteen years in Ladakh, and is one of the few foreigners fluent in the language. She describes the region's unique traditions, its household and community autonomy, and its equilibrium with the climate and natural resource base. Ladakhi culture recognizes and teaches the fundamental connectedness and interdependence of elements of life, based on a long Buddhist tradition. In the preface, the Dalai Lama endorses Norberg-Hodge's analysis of the frugality and

self-reliance of Ladakh and the respect of its people for the natural environment on which they depend.

Changes in Ladakh over the past two decades have seriously threatened its environment, culture, and economic sustainability. Norberg-Hodge has experienced first hand the shift from a dependence on local resources to imported fossil fuels, from natural crop production methods to chemical pesticides, and from locally produced foods to processed and imported products. This transformation has exacted a high price. Conversion to a cash economy has undermined community interdependence and created a desire to accumulate wealth. The effect has been greatest on youth, making them dissatisfied with farming, village isolation, and traditional family values. The society now depends on outside resources, lacks family and community self-reliance, and generates waste and pollution that previously were unknown. Western-style consumerism has destroyed an ecological balance and social harmony that prevailed for centuries in this unique land.

Initiatives are underway to reverse this trend, with both local and international support. Norberg-Hodge explains that the Ladakh Project was founded to encourage "progress toward more ecological and community-based ways of living." It stresses "the urgent need to counter political and economic centralization, while encouraging a truly international perspective through increased cultural exchange" and encourages "a shift from ever more narrow specialization toward a broad systemic perspective—an approach that emphasized relationship and context rather than isolated phenomena." Specific technologies include trombe walls (passive solar heat collectors), solar cookers and water heaters, hydraulic ram pumps, and simple greenhouses for vegetables. Norberg-Hodge comments that "these technologies make sense economically, environmentally, and culturally. By encouraging a more human-scale and centralized development pattern, they actively support traditional structures rather than destroying them." The project has evolved into the Ladakh Ecological Development Group that was inaugurated by Indira Gandhi in 1984 and consecrated by the Dalai Lama.

Ancient Futures is valuable reading for its description of a region and an agriculture little known to most Westerners. It also describes the consequences of unplanned development, with unintended ecological, economic, and social harm accompanying industrialization and reliance on fossil fuels. Most important to people in developed countries, Ladakh provides a valuable model of how people can live in harmony with their climate, their resources, and each other. For anyone concerned about sustainable development, this book is a "must read." For undergraduates or others concerned about the future, it offers a striking introduction to alternative thinking about development, resources and the environment.

Charles Francis, Director, Center for Sustainable Agricultural Systems, University of Nebraska, Lincoln, NE 68583.

Nationwide Expansion of Integrated Crop Management Program Approved

The USDA has authorized the Integrated Crop Management (ICM) program as a nationwide cost-share option under its Agricultural Conservation Program (ACP). Expansion of ICM from a pilot basis to a nationwide option had been recommended in the latest annual review of ACP. Actual implementation of the expanded ICM program will now depend on acceptance by individual state technical committees and the availability of qualified technical resources.

ICM provides farmers with assistance to implement sustainable systems involving practices such as integrated pest management, conservation tillage, and nutrient management. The cost-sharing is set at 75% of the system cost, with current upper limits of $7 per acre for small grain, forage, hay and row crops, and $20 per acre for specialty crops such as vegetables and fruits. Participating farmers are expected to carry out the practices for three consecutive years.

Proponents of ICM point out that successful implementation of ICM and similar state programs has led to significant reductions in farm-level use of commercial fertilizers, pesticides, and energy. A similar state program in Iowa, started in 1987, has helped farmers reduced their nitrogen use on corn by 20 percent, while maintaining high yields.

Sustainable Farming Quarterly Spreads the Word

The *Sustainable Farming Quarterly* is a unique regional newsletter, funded by the SARE program, that spreads the word about regionally appropriate sustainable farming technology and information to producers and the agricultural research and service sectors in Idaho, Montana, Oregon, Utah, Washington, and Wyoming. The newsletter's information is compiled from interviews with and articles by scientists and farmers, from unpublished research reports, and from research bulletins and other types of material not readily accessible to the general public.

Since its inception in December, 1989, *Sustainable Farming Quarterly* has provided high quality, current, useful sustainable farming information to the public in a timely fashion. It is available at no cost to farmers in the six-state region, extension staff, Soil Conservation Service staff, and the media; subscriptions for people outside the six-state region are $8. For further information, contact Sally Hilander, Editor, c/o Alternative Energy Resources Organization, Helena, MT 59601; (406)443-7272 or (406)442-8396.

UPCOMING EVENTS

November 15 is the deadline for abstracts of 300 words or less for papers for *Great Plains Animal Waste Conference on Confined Animal Production and Water Quality*, to be held in Denver, CO, October 19-21, 1994; contact Dr. John Nienaber, Chairman Organizing Committee, U.S. Meat Animal Research Center, P.O. Box 166, Clay Center, NE 68933-0166; (402)762-4274.

November 18-20, *1993 Acres USA Conference* will be held in Kansas City, MO; contact Acres USA, PO Box 9547, Kansas City, MO 64133; (816) 737-0064.

November 19-20, *Fourth Annual Rural Women's Conference* will be held in Hutchinson, KS; contact Linda Hessman, Catholic Rural Life Office, P.O. Box 137, Dodge City, KS 67801; (316)227-1535 or Char Henton, FACTS, 1-800-321-3276.

December 2-3, *North American Grazing Conference* will be held in Jackson, MS; contact Carolyn Thornton, The Stockman Grass Farmer, PO Box 9608, Jackson, MS 39286; (601)264-8277.

December 6, *Community Supported Agriculture Conference* will be held at the University of California, Davis; contact Community Alliance with Family Farmers, PO Box 464, Davis, CA 95617; (916) 756-8518.

December 8, *Open House* will be held at the Kerr Center for Sustainable Agriculture headquarters south of Poteau, OK; contact Lara Ervin, KCSA, P.O. Box 588, Poteau, OK 74953; (918)647-9123.

December 9, *Second Annual Fertilizer Research and Education Conference* will be held at the University of California, Davis; contact Jacques Franco or Casey Walsh, California Department of Food and Agriculture, (916)653-5340.

January 5-12, 1994, *Ranching for Profit School* will be held in Fort Collins, CO; contact Elaine Kelly, Ranch Management Consultants, 7719 Rio Grande Blvd. NW, Albuquerque, NM 87107; (508) 898-7417 or (505)821-4214.

January 6-12, 1994, *Independent Organic Inspectors Association Inspector Training Course* will be held in High Springs, FL; contact IOI Association, Rt. 3 Box 162-C, Winona, MN 55987; (507) 454-8310.

January 7-8, 1994, *Oklahoma Horticulture Industries Show* will be held on Northeast Campus, Tulsa Junior College, Tulsa, OK; contact Lara Ervin, KCSA, P.O. Box 588, Poteau, OK 74953; (918) 647-9123.

January 8, 1994, *5th Annual Southern Plains Conference* will be held in Amarillo, TX; contact Darryl Birkenfeld, 735 Brevard, Hereford, TX 79045; (806)364-1550.

January 16-18, 1994, *Which Row To Hoe?*, the 13th annual winter conference of the Northern Plains Sustainable Agriculture Society, will be held in Fargo, N.D.; contact NPSAS, Box 36, Maida, N.D. 58255; (701)256-2424.

January 19-21, 1994, *Agriculture in Transition: On the Move to Sustainability*, the 14th annual Ecological Farming Conference, will be held as the Asilomar Conference Center, Pacific Grove, CA; contact the Committee for Sustainable Agriculture, 47 Linden Road, Watsonville, CA 95076; (408)761-9525.

January 25-May 18, 1994, *New Women, New Earth*, a residential semester, will be held at Grailville, a 300-acre organic farm in Loveland, OH; contact Audrey Sorrento or Cathy Hale, Grailville, 932 O'Bannonville Road, Loveland, OH 45140-9705; (513)683-2340.

January 26-27, 1994, *The Business and Science of Special Forest Products: A Conference and Exposition*, will be held at the Washington Country FairPlex in Hillsboro, OR; contact Christy Dorsey, Western Forestry and Conservation Association, 4033 SW Canyon Road, Portland, OR 97221; (503)226-4562.

January 28-29, 1994, *13th annual Organic Agriculture Conference* will be held in Guelph, Ontario; contact Tomas Nimmo, Canadian Organic Growers, (705)444-0923.

February 3-6, 1994, the *11th Annual California Farm Conference* will be held in Ventura, CA; contact Pasadena Certified Farmers Market Association, 454 Euclid Avenue, Pasadena, CA 91101, (818)449-0179; or Marin County Farmers Market, 1114 Irwin St., San Rafael, CA 94901; (800)897-FARM.

February 5, 1994, *Beyond Organic*, a forum, will be held in Sinsinawa, WI; contact Ann Krush, Iowa's Organic Information Network, P.O. Box 1612, Fairfield, IA 52556, (515)472-0112; or 216 North Russell, Ames, IA 50010, (515)233-0019.

February 15-18, 1994, *25th Silver Anniversary Conference and Trade Exposition of the International Erosion Control Association* will be held in Reno, NV; contact IECA, P.O. Box 4904, Steamboat Springs, CO 80477-4904; (303)879-3010.

March 7-10, 1994, *National Pesticide Management Conference* will be held in St. Louis, MO; contact Lyn Kirschner, Conservation Technology Information Center, 1220 Potter Drive, #170, West Lafayette, IN 47906; (317)494-9555.

March 12-13, 1994, *Cultivate Community*, the annual conference of Northeast Organic Farmers Association of New York, will be held at Tompkins/Cortland Community College, Dryden, N.Y.; contact NOFA-NY, P.O. Box 21, South Butler, N.Y. 13154; (315)365-2299.

State Reports

Pesticides Suspended in California: California Environmental Protection Agency's Department of Pesticide Regulation has suspended the registration of 47 pesticides whose manufacturers ignored a notice last year to submit health data on their products. The chemicals are the active ingredients in about 225 pesticide products, including pesticides used in agriculture. For a list of the chemicals, request *March 1993 Status Report, AB 1742 Chemicals* from the Department of Pesticide Regulation, Registration Branch, Attention: SB 950 Office, 1220 N St., Sacramento, CA 95814; (916)654-0533.

IPM Better for Rootworm in Minnesota: Minnesota farmers use more soil insecticides for "insurance" against corn rootworm than they need, according to Minnesota Extension Service research. Integrated pest management with scouting and reduced rates could improve the efficiency of soil insecticide inputs, save input costs, and protect corn roots as well. For more details, contact Ken Ostlie at the Extension Service, (612)624-9272.

High Response to Cancer Survey in Nebraska: A cancer control program, *Harvest for a Lifetime!*, has received a "fantastic" response from Nebraska farmers, with at least 1,800 replies already received from the 4,873 families who were mailed response cards offering free chemical-resistant gloves and information about other protective clothing. A previous Nebraska survey found that 72% of 800 farm-resident respondents said they were worried about getting cancer from chemicals. The latest mailing is part of a project started in 1991 to alert farm families to the cancer-related dangers of farm chemicals, tobacco, and sunlight.

Ohio Land Link Launched: A project just launched in Ohio is seeking to connect beginning farmers with retiring farmers and other landowners, to help new farmers gain access to land while providing a needed service to retiring farmers and others who wish to see their land remain a family farm. Ohio Land Link is modeled after a program started several years ago by the Center for Rural Affairs in Nebraska. Those interested in participating may contact Kamyar Enshayan, c/o Stratford Ecological Center, 3083 Liberty Rd., Delaware, OH 43105.

Small Farms, Not Counted by Census, May Be Deprived of Benefits

The U.S. Census Bureau may not be counting thousands of small farms across the country, and as a result, the counties those farms are in could be deprived of federal funding for USDA environmental and conservation projects, according to a report in the *Pocono Record* in Stroudsburg, Pennsylvania. The Census Bureau is required to count and include all farmers who raise $1,000 worth of products in its U.S. agriculture census, which is calculated every five years by mailing forms to farmers.

According to the newspaper's report, as many as three-quarters of the farms in Monroe County, Pennsylvania, may be uncounted by the Census Bureau. The USDA's field office in that county estimates there are 800 farmers in the county; yet Census Bureau officials estimate their final total, to be released later this year, will be 200 to 300.

"Estimates of the number of small farms it [the Census Bureau] may not count nationally range from the tens of thousands to hundreds of thousands," according to the newspaper account. "From Washington, D.C., the U.S. Department of Agriculture official working most closely with the nation's small farms said 'America's small-scale and part-time farms are an overlooked resource.'"

If a county's agricultural population is undercounted, programs that assist farming are either in danger of being cut back or not offered at all, a USDA official told the newspaper. Examples of such programs include conservation seedings, reforestation efforts, woodlot stewardship, wildlife habitat management, and cropping programs that help stabilize and improve the soil.

Federal Government Urged to Purchase Organic, Low-Residue Foods

Five public interest groups have written to Vice President Albert Gore, Jr., asking him to "encourage the federal government to pursue the option of buying organic and certified low-residue food for use in school lunches, HeadStart, hospitals, the military, and other federal programs that purchase large quantities of food." Signing the letter were representatives of Consumers Union, Environmental Working Group, National Parent-Teacher Association, Physicians for Social Responsibility, and Public Voice for Food and Health Policy. The letter recommended food purchasing specifications be modified to achieve 25% organic and certified low-residue foods in all federal food programs within five years.

Referring to the Clinton Administration's recent commitment to reducing the use of pesticides, those signing the letter said, "Creating a market for organic and certified low-residue foods will complement needed legislative reform and help implement this important new policy....Just as automobiles that use less gas are better for the environment, fruits and vegetables that contain less pesticides are better for our children and all consumers. And farming systems that produce such foods do so with less impact on the environment."

Guide for authors

The American Journal of Alternative Agriculture (AJAA) publishes original research on biological, physical, or social science aspects of alternative agriculture. We particularly welcome multi-disciplinary studies, but papers from a specific discipline also are invited. However, since AJAA readership is much broader than for a single-discipline journal, highly specialized terminology should be explained or avoided. The significance of a statement, or the reasoning behind a conclusion, may have to be spelled out more than in a more specialized journal. See Vol. 5, No. 1, pp 2 & 3, for an explanation of the various categories of articles.

Units

Research papers should use the International (SI, or metric) system throughout. Occasional use of common unit equivalents in parentheses is permitted, mainly for relatively exotic SI units.

for Alternative Agriculture was founded in 1983 to
misperceptions about the economic and environmen-
of alternative farming systems. Through research,
grassroots advocates, farmers, universities, and govern-
on sustainable farming systems and technologies.

fill out the information inside and enclose your tax-

R ALTERNATIVE AGRICULTURE

When citing material that has been covered in more than one format, such as the typescript of a conference presentation and a journal article, preference should be given to the version that is most readily available, and that is likely to remain so. Generally this means standard publication channels, such as books, journals, and regular government report series. Unpublished or informally-published material should be cited only when no alternative form exists.

References should be listed in alphabetical order by author's name, and by year for a particular author (with letters after the year if needed). If a sole author is also the lead author of papers with multiple authors, use the following order: single author (by year); two authors (alphabetically by second author's name); three or more authors (by year). Repeat the author's name for each reference. Use initials only for first and middle names. Give the names of all authors in the reference; never use "et al."

Use full names of journals, institutions, conferences, etc., except for extremely familiar abbreviations like "Dept." Remember that an abbreviation familiar to you may not be familiar to readers outside your field. If in doubt, write it out.

The reference list uses no quotation marks, italics, boldface, or underlining. Only the names of books and periodicals are in initial capitals. Names of papers, book chapters, pamphlets, and bulletins are not capitalized. Page numbers are written out in full (e.g., 1108-1123, not 1108-23). The volume is given if page numbers begin at 1 for each issue.

Citing references

Cite references in the text by last name and year, with hapter or page numbers if the reference is a book or lengthy eport. For two authors, give both names. Do not use "et al." nless there are at least three authors.

ootnotes

AJAA does not use bibliographic or substantive footnotes. ll bibliographic references should be at the end of the text. nstead of substantive footnotes, include the material in the ain text or consider eliminating it.

lanuscript preparation

The entire manuscript, including abstract and references, ould be typed on one side of standard-size paper, double aced, with margins of at least one inch all around. Starting ith the title page, label all pages in the upper righthand rner with the lead author's last name and the page number. o not use hyphens unless the hyphen is part of the word.

Follow the section headings style used in this AJAA issue. ll headings are flush left, with no underlining or italics.

Tables should fit on one page, be numbered consecutively with Arabic numerals, and be on a separate sheet. Leave extra space to separate columns. Every figure and table should be mentioned at least once in the text.

Submission of manuscripts

Submit four high-quality copies to Editor, American Journal of Alternative Agriculture, Suite 117, 9200 Edmonston Road, Greenbelt, MD 20770. The cover letter should state that the manuscript is an original contribution that has not been published elsewhere in substantially the same form; that it is not currently under consideration elsewhere, and that permission has been obtained for any copyrighted material used.

State Reports

Pesticides Suspended in California: California Environmental Protection Agency's Department of Pesticide Regulation has suspended the registration of 47 pesticides whose manufacturers ignored a notice last year to submit health data on their products. The chemicals are the active ingredients in about 225 pesticide products, including pesticides used in agriculture. For a list of the chemicals, request *March 1993 Status Report, AB 1742 Chemicals* from the Department of Pesticide Regulation, Registration Branch, Attention: SB 950 Office, 1220 N St., Sacramento, CA 95814; (916)654-0533.

IPM Better for Rootworm in Minnesota: Minnesota farmers use more soil insecticides for "insurance" against corn rootworm than they need, according to Minnesota Extension Service research. Integrated pest management with scouting and reduced rates could improve the efficiency of soil insecticide inputs, save input costs, and protect corn roots as well. For more details, contact Ken Ostlie at the Extension Service, (612)624-9272.

High Response to Cancer Survey in Nebraska: A cancer control program, *Harvest for a Lifetime!*, has received a "fantastic" response from Nebraska farmers, with at least 1,800 replies already received from the 4,873 families who were mailed response cards offering free chemical-resistant gloves and information about other protective clothing. A previous Nebraska survey found that 72% of 800 farm-resident respondents said they were worried

from chemicals. The latest mailing is part of a project started in 1991 to alert farm families to the cancer-related dangers of farm chemicals, tobacco, and sunlight.

Ohio Land Link Launched: A project just launched in Ohio is seeking to connect beginning farmers with retiring farmers and other landowners, to help new farmers gain access to land while providing a needed service to retiring farmers and others who wish to see their land remain a family farm. Ohio Land Link is modeled after a program started several years ago by the Center for Rural Affairs in Nebraska. Those interested in participating may contact Kamyar Enshayan, c/o Stratford Ecological Center, 3083 Liberty Rd., Delaware, OH 43105.

Recycled paper

Small Farms, Not Counted by Ce

The U.S. Census Bureau may not be counting thousands of small farms across the country, and as a result, the counties those farms are in could be deprived of federal funding for USDA environmental and conservation projects, according to a report in the *Pocono Record* in Stroudsburg, Pennsylvania. The Census Bureau is required to count and include all farmers who raise $1,000 worth of products in its U.S. agriculture census, which is calculated every five years by mailing forms to farmers.

According to th
as many as three-q
Monroe County, I
uncounted by the
USDA's field offi
mates there are 80(
yet Census Bureau
final total, to be r
will be 200 to 300.

"Estimates of
farms it [the Cen
count nationally r
thousands to hund
cording to the new
Washington, D.C.

BUSIN
FIRST CLASS
POST

Henry A. Walla
for Alternative A
9200 Edmonston Ro
Greenbelt, Maryland

Federal Government Urged to Purchase Organic, Low-Residue Foods

Five public interest groups have written to Vice President Albert Gore, Jr., asking him to "encourage the federal government to pursue the option of buying organic and certified low-residue food for use in school lunches, HeadStart, hospitals, the military, and other federal programs that purchase large quantities of food." Signing the letter were representatives of Consumers Union, Environmental Working Group, National Parent-Teacher Association, Physicians for Social Responsibility, and Public Voice for Food and Health Policy. The letter recommended food purchasing specifications be modified to achieve 25% organic and certified low-residue foods in all federal food programs within five years.

Referring to the Clinton Administration's recent commitment to reducing the use of pesticides, those signing the letter said, "Creating a market for organic and certified low-residue foods will complement needed legislative reform and help implement this important new policy....Just as automobiles that use less gas are better for the environment, fruits and vegetables that contain less pesticides are better for our children and all consumers. And farming systems that produce such foods do so with less impact on the environment."

Guide for authors

The American Journal of Alternative Agriculture (AJAA) publishes original research on biological, physical, or social science aspects of alternative agriculture. We particularly welcome multi-disciplinary studies, but papers from a specific discipline also are invited. However, since AJAA readership is much broader than for a single-discipline journal, highly specialized terminology should be explained or avoided. The significance of a statement, or the reasoning behind a conclusion, may have to be spelled out more than in a more specialized journal. See Vol. 5, No. 1, pp 2 & 3, for an explanation of the various categories of articles.

Units

Research papers should use the International (SI, or metric) system throughout. Occasional use of common unit equivalents in parentheses is permitted, mainly for relatively exotic SI units.

Title page

The title page should give the following information (all flush left): 1) title of the paper; 2) names of authors; 3) affiliation and office address of authors, and 4) acknowledgements, if any. See examples in this issue of AJAA.

Abstract

The abstract should be 200 to 400 words suitable for readers from a broad range of disciplines. It should avoid highly-specialized terminology that might be appropriate for a single discipline journal. Take particular care that the significance of the work is made clear, even to readers from a different field.

Key words

Provide subject matter key words suitable for use in scientific indexing.

Reference list

When citing material that has been covered in more than one format, such as the typescript of a conference presentation and a journal article, preference should be given to the version that is most readily available, and that is likely to remain so. Generally this means standard publication channels, such as books, journals, and regular government report series. Unpublished or informally-published material should be cited only when no alternative form exists.

References should be listed in alphabetical order by author's name, and by year for a particular author (with letters after the year if needed). If a sole author is also the lead author of papers with multiple authors, use the following order: single author (by year); two authors (alphabetically by second author's name); three or more authors (by year). Repeat the author's name for each reference. Use initials only for first and middle names. Give the names of all authors in the reference; never use "et al."

Use full names of journals, institutions, conferences, etc., except for extremely familiar abbreviations like "Dept." Remember that an abbreviation familiar to you may not be familiar to readers outside your field. If in doubt, write it out.

The reference list uses no quotation marks, italics, boldface, or underlining. Only the names of books and periodicals are in initial capitals. Names of papers, book chapters, pamphlets, and bulletins are not capitalized. Page numbers are written out in full (e.g., 1108-1123, not 1108-23). The volume is given if page numbers begin at 1 for each issue.

Citing references

Cite references in the text by last name and year, with chapter or page numbers if the reference is a book or lengthy report. For two authors, give both names. Do not use "et al." unless there are at least three authors.

Footnotes

AJAA does not use bibliographic or substantive footnotes. All bibliographic references should be at the end of the text. Instead of substantive footnotes, include the material in the main text or consider eliminating it.

Manuscript preparation

The entire manuscript, including abstract and references, should be typed on one side of standard-size paper, double spaced, with margins of at least one inch all around. Starting with the title page, label all pages in the upper righthand corner with the lead author's last name and the page number. Do not use hyphens unless the hyphen is part of the word.

Follow the section headings style used in this AJAA issue. All headings are flush left, with no underlining or italics.

Tables should fit on one page, be numbered consecutively with Arabic numerals, and be on a separate sheet. Leave extra space to separate columns. Every figure and table should be mentioned at least once in the text.

Submission of manuscripts

Submit four high-quality copies to Editor, American Journal of Alternative Agriculture, Suite 117, 9200 Edmonston Road, Greenbelt, MD 20770. The cover letter should state that the manuscript is an original contribution that has not been published elsewhere in substantially the same form; that it is not currently under consideration elsewhere, and that permission has been obtained for any copyrighted material used.

How you can help support the scientific and educational needs of a sustainable agricultural system

A growing number of Americans have become concerned about the long-term sustainability of our food production system. Farmers and agricultural scientists are among those raising questions about the growing dependence of modern farming on nonrenewable resources, the depletion of our resource base through soil erosion, and heavy reliance on chemical fertilizers and pesticides. Continued heavy reliance on farm chemicals is questioned because they have become an expensive production input. Their widespread use also raises questions about human and animal health, food quality and safety, environmental quality, and the continued demise of the family farm.

Low-input alternative farming methods address these economic and environmental challenges. Alternative production systems point the way toward more profits, more individual choice, and long-term sustainability for our food system. More must be done to develop effective ways to make sure research, education, and information sources are readily available to farmers who want to adopt these techniques.

The Henry A. Wallace Institute for Alternative Agriculture needs your help in meeting this challenge. We are a nonprofit tax-exempt research and education organization formed to encourage and facilitate the adoption of low cost, resource conserving, and environmentally sound farming methods. We work directly with government agencies, colleges and universities, producer groups, and other institutions that provide research, education and information services to farmers.

The Institute also provides these services:

- *A resource to lawmakers and others who influence agricultural research, education, and information policy*
- *A voice for alternative agriculture in Washington*
- *A sponsor of research and education outreach programs*
- *A national clearinghouse for information on alternative agriculture*
- *A publisher of reliable scientific information on agricultural sustainability*

If you're interested in helping us, please contact the Henry A. Wallace Institute for Alternative Agriculture, 9200 Edmonston Road, Greenbelt, MD 20770. The phone number is (301) 441-8777.

HENRY A. WALLACE INSTITUTE FOR
ALTERNATIVE AGRICULTURE, INC.